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WATER RESOURCES OF THE HEBER-KAMAS-PARK CITY AREA NORTH-CENTRAL UTAH

by
C. H. Baker, Jr.
Hydrologist, U. S. Geological Survey

With a section on

A GRAVITY AND AEROMAGNETIC SURVEY OF HEBER AND RHODES VALLEYS

by
D. L. Peterson
Geologist, U. S. Geological Survey

Prepared by the U. S. Geological Survey
In cooperation with
The Utah Department of Natural Resources
Division of Water Rights

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ABSTRACT

The Heber-Kamas-Park City area encompasses about 810 square miles in Wasatch and Summit Counties, in north-central Utah, and includes four mountain valleys—Heber Valley, Rhodes Valley, Parleys Park, and Round Valley—with most of the surrounding watersheds. Parleys Park and most of Rhodes Valley are in the Weber River drainage basin; Heber and Round Valleys are in the Provo River drainage basin.

The Provo River rises in the southwestern Uinta Mountains and flows to Utah Lake. At Deer Creek Dam, on the boundary of the study area, the average annual discharge of the Provo River for the 14-year period 1953-67 was 256,300 acre-feet per year; an additional 33,900 acre-feet per year (average) was diverted for use outside the drainage basin. An average of 68,000 acre-feet of water per year is added to the Provo River by diversion from other drainage basins.

The Weber River has its headwaters in the northwestern Uinta Mountains, and flows to Great Salt Lake. The average discharge of the Weber River below Wanship Dam near the north end of the study area, for the 10-year period 1957-67, was 110,000 acre-feet per year. During that period, an average of 50,600 acre-feet per year was diverted from the drainage basin above Wanship Dam. The surface-water discharge from Parleys Park enters the Weber River below Wanship Dam through East Canyon Creek and Silver Creek; the discharge from Parleys Park averages about 20,000 acre-feet per year.

The consolidated rocks of the Wasatch Range and Uinta Mountains contain large quantities of ground water, mostly in fractures and solution openings, and numerous springs discharge water from the consolidated rocks. Despite the abundance of springs and the fact that mine workings in the Wasatch Range tap large flows of ground water, most wells yield only small supplies of water from the consolidated rocks. The primary permeability of the rocks is low, and wells can produce large yields only if they intersect fractures and solution openings.

Consideration of the water budget for Deer Creek Reservoir, astride the Charleston thrust fault, indicates that there is no net loss of water from the reservoir through the fault. An unbalance of about 17,000 acre-feet of water per year in the water budget for the valley fill in Heber Valley, however, may represent outflow from the valley through the consolidated rocks.

Most of the wells in the area derive water from the unconsolidated alluvial fill in the four valleys. The valley fill consists of a poorly sorted mixture of rock material ranging in size from clay through boulders. There is no evidence to suggest the presence of zones of either very high or very low permeability in any of the valleys; and the valley fill in all the valleys is saturated, generally to within a few feet of the land surface, mostly with unconfined ground water.

Geophysical studies indicate that the valley fill may be as much as 800 feet thick in the deepest parts of Heber Valley and more than 300 feet thick in most of Rhodes Valley. Rocks of Tertiary and Quaternary age are more than 1,600 feet thick in the northern part of Rhodes

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INTRODUCTION

This report on the water resources of the Heber-Kamas-Park City area was prepared by the U. S. Geological Survey in cooperation with the Utah Department of Natural Resources, Division of Water Rights. The primary purpose of the report is to provide the Division of Water Rights with the basic hydrologic information needed for the effective administration of water rights in the area.

The study on which this report is based was an overall evaluation of the water resources of the Heber-Kamas-Park City area, and it was made during the period July 1966-December 1968. Principal emphasis in the study was on ground-water resources, because the surface water of the area is fully appropriated, and water for expanded future needs will have to be derived from ground-water sources. The primary purposes of the study were to determine the quantity and quality of ground water available in the area, to determine the relation of ground water to surface water in the area, and to estimate the effects of increased ground-water withdrawals on streamflow from the area.

This report describes the general surface-water hydrology of the study area, evaluates the quantity and quality of ground water available from the several aquifers, and discusses the relationship of ground water to surface water in the area. The basic data on which the interpretations and conclusions in this report are based are included in tables 3-7 in the appendix; the data consist of selected data available for the period prior to July 1966 and of field data gathered from July 1966 to September 1968.

A short report by D. L. Peterson, describing the results of geophysical studies in part of the project area, is included in the appendix.

Description of the area

The Heber-Kamas-Park City area lies between the Uinta Mountains and the Wasatch Range in Summit and Wasatch Counties, north-central Utah (fig. 1). It includes four mountain valleys—Heber Valley, Rhodes Valley, Parleys Park, and Round Valley—and most of the surrounding drainage area. Although the study area includes about 810 square miles, this study was most concerned with the availability of water in the four valleys (total area about 140 square miles), for it is in the valleys that the population is concentrated and the demand for water is greatest.

About 87 percent of the estimated 8,650 people (1960 census) in the area live in the 16 communities in the valleys, but most of the population are directly or indirectly dependent on agriculture for their livelihood. Dairy farming is the principal source of income in the region, followed by the raising of sheep and beef cattle. The mountains surrounding the valleys furnish summer pasture for livestock, and the irrigated land in the valleys supplies the necessary winter feed. Park City was once the center of a major lead- and silver-mining district, but only two mines in the area were being worked in 1968. Recreational development (for skiing, fishing, and the like) is an increasing contributor to the economy of the area.

The area is approximately bisected by a drainage divide; the northern part, including Parleys Park and most of Rhodes Valley, is drained by the Weber River, and the southern part, including Heber Valley and Round Valley, is drained by the Provo River. These major streams both have their beginnings in the western Uinta Mountains, and both are part of the Great Basin drainage system; the Weber flows north and west to Great Salt Lake, and the Provo flows south and west to Utah Lake.

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per year. The difference, an average of 1,600 acre-feet per year, plus any diversions from Beaver Creek, is the conveyance loss of the canal.

The discharge of Beaver Creek is not measured, but the creek enters the Weber River between the stations near Oakley (site 2, fig. 5) and near Peoa (site 4, fig. 5). No other perennial tributaries enter this reach of the river, although the Weber-Provo diversion is taken out: the difference in average discharge at the two stations, adjusted for the canal diversion, should therefore approximate the average discharge of Beaver Creek. Although the average discharge of the Weber River near Oakley for the entire long period of record is 159,300 acre-feet per year, the discharge near Oakley for the period of record available near Peoa is smaller—about 139,000 acre-feet per year. The Weber-Provo Canal diversion (average for the period 50,600 acre-feet per year) is removed from the river below this station, leaving about 88,500 acre-feet per year as the discharge of the main river above the gaging site near Peoa. The average discharge at the station near Peoa, however, is 107,100 acre-feet per year; the river gains 18,600 acre-feet per year (average) between the two stations. Some of the gain is undoubtedly ground-water discharge from the unconsolidated deposits in Rhodes Valley, but most of the gain is the discharge of Beaver Creek; an arbitrary estimate of the contribution from Beaver Creek is about 17,000 acre-feet per year.

The gaging station on East Canyon Creek is many miles downstream from the area of this study; less than half the drainage area of the creek above the gaging station is in the study area. It is probable, therefore, that the average discharge of East Canyon Creek from the study area does not exceed 15,000 acre-feet per year.

Chemical quality

All surface water from the Weber River drainage basin that was analyzed was chemically suitable for domestic, stock, and irrigation use. Chemical analyses of seven samples of surface water from the Weber River drainage basin are reported in table 5. All the samples are dilute calcium bicarbonate type water. The most concentrated of the seven samples (445 mg/l) was from Silver Creek at the old Silver King Mine near Park City. The stream at that point almost certainly included ground water discharging from the mine tunnels, which is more concentrated than most surface water in the area.

GROUND-WATER HYDROLOGY

Ground water in the consolidated rocks

The consolidated rocks in the Heber-Kamas-Park City area are an important element in the total ground-water system of the area. Springs and wells that discharge water from the consolidated rocks are the principal source of supply for water users in the mountains. Moreover, much of the water that enters the rocks in the mountains either reappears as springs along the margins of the valleys or moves into the unconsolidated valley fill as recharge in the subsurface.

Water-bearing units

The consolidated rocks underlying the Heber-Kamas-Park City area range in age from Precambrian to Quaternary. A generalized stratigraphic summary of the consolidated rocks is

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given in table 1. This is a composite section and nowhere in the area are all the formations present. Plate 2 is a geologic map showing the areal distribution of the various rock units.

The rocks in both the Wasatch Range and the Uinta Mountains have been subjected to considerable deformation and are greatly fractured, faulted, and folded. The most prominent displacement in the area is the Charleston thrust fault, which crosses the south end of Heber Valley. Several smaller thrust faults have been mapped, and high-angle faults of small displacement are numerous. Joints and fractures are ubiquitous, and solution openings are common in the carbonate rocks. These openings and the faults play a major role in controlling the movement of ground water in the area. Small folds are abundantly present, but they exert little influence on ground-water movement

Water moves through the rocks along the abundant fractures, solution openings, and fault planes, and thus any formation may be, at least locally, water bearing. In his report on the Park City Mining District, Boutwell (1912, p. 24) observed that the water in the mines came principally from "the red shale and massive quartzite" (Woodside Formation and Weber Quartzite). Officials of the United Park City Mining Co. agree that most of the water in that company's workings appears in tunnels that penetrate the Weber Quartzite (J. Ivers, Jr., oral commun., 1967).

In 1967, the few wells in the project area that were finished in the consolidated rocks derived their water from only 11 of the more than 30 geologic units under the area. The producing formations were the Quaternary tufa deposits, the Tertiary volcanic rocks, the Knight Conglomerate, the Preuss Sandstone, the Twin Creek Limestone, the Nugget Sandstone, the Chinle Formation, the Ankareh Formation, the Thaynes Formation, the Oquirrh Formation, and the Weber Quartzite. Other units, especially the carbonate rocks of Pennsylvanian, Mississippian, and Devonian age, yield water to springs in the area, and Feltis (1966, p. 14-17) states that in the Uinta Basin, southeast of the study area, some water is obtained from the Park City Formation of Permian age and from the Uinta Formation of Tertiary age. More wells in the study area obtain water from the Tertiary volcanic rocks than from any of the other formations, probably because the volcanic rocks are the shallowest consolidated rocks in the areas where most of the bedrock wells are located.

Aquifer characteristics

In a broad way, for the purpose of evaluating areal movement of ground water, the highly fractured rocks of the Wasatch Range can be regarded as a single homogeneous aquifer, and the same is probably true of the rocks in the Uinta Mountains. On the small scale involved in selecting sites for the development of water supplies, however, the aquifers are grossly heterogeneous. Information from drillers' tests of wells finished in the consolidated rocks shows that the development of supplies of water sufficient for irrigation, industrial needs, or public supplies from the consolidated rocks depends upon the wells intersecting water-bearing fractures. Even in a fracture system that is properly described as "closely spaced," however, the distance between adjacent fractures may be very large compared to the diameter of a well. Hence, the construction of wells to intercept water moving through fractured rocks tends to be a "hit-or-miss" affair. The large discharge of water from mine tunnels near Park City should not be taken as an indication of the potential yield of wells. Each tunnel drains many miles of workings, whereas a well usually drains a relatively small area. Small supplies, adequate for domestic use in single-family dwellings, can probably be obtained from several of the consolidated rock units.

Drillers' reports of a few wells (table 3) include the results of pumping tests, generally of only a few hours duration. The test results were evaluated by the method of Theis and others (1963) to derive the values of aquifer transmissivity included in table 1.

Table 1.—Generalized stratigraphic summary of the consolidated rocks of the Heber-Kamas-Park City area

Age	Formation	Lithology and thickness	Water-bearing properties
Quaternary	Tufa deposits	Calcareous tufa deposited from the water of thermal springs. Nearly pure calcium carbonate. Very porous. Thickness unknown, but locally exceeds 70 feet.	Yields some water to wells. Numerous warm springs flow from tufa deposits, but source of water is probably underlying beds. Tufa apparently is permeable and transmits water readily.
Tertiary	Extrusive igneous rocks	Chiefly andesitic pyroclastics with some intercalated flow rocks, includes *Keetley Volcanics* and *Tibble Formation*. Thickness uncertain, but reportedly may exceed 1,000 feet.	Yields some water to wells, chiefly in the Parleys Park area, and to numerous small springs. Most of the observed springs are along fractures or contacts. Transmissivity estimated from drillers' reports as about 270 $ft^3/d/ft$.
	Intrusive igneous rocks	Includes a few small bodies of basic rocks in the Uinta Mountains and many large masses of granitic rocks in the Wasatch Range. Thickness unknown.	Intrusive rocks yield some water to mine tunnels from fractures, but have little significance as aquifers in the area.
	Fowkes Formation	Tuffaceous and limy beds and local conglomeratic lenses. Thickness and stratigraphic relations uncertain. Present only in extreme northwestern part of the study area.	Not known to yield water in the study area.
	Uinta Formation	Fluvial and lake deposits. Present only in the extreme south end of the study area. Thickness in the area unknown.	Not known to yield water in the study area, but reportedly supplies some wells locally in the Uinta Basin to the southeast (Feltis, 1966).
	Knight Conglomerate	Gray and reddish conglomerate in massive beds, chiefly fluvial. Thickness as much as 2,000 feet.	Yields water to a few wells in the northern part of the study area. Transmissivity probably less than 135 $ft^3/d/ft$.
Tertiary and Cretaceous	Wanship Formation of Eardley (1952)	Marine sandstone and shale. Thickness as much as 5,000 feet.	Not known to yield water in the study area.
Cretaceous	Echo Canyon Conglomerate of Eardley (1944)	Conglomerate and conglomeratic sandstone and some shale and a few coal beds. Thickness at least 3,100 feet.	Not penetrated by wells in the study area, but supplies a few springs.
	Frontier Formation	Nonmarine and marine sandstone, shale, and coal. Thickness more than 2,100 feet.	Not penetrated by wells in the study area. Probable source of a few small springs.
	Price River Formation	Conglomerate and shale. Thickness as much as 1,500 feet, but probably less in the study area. Present only in the extreme south end of the area.	Not known to yield water in the study area.
	Aspen Shale	Dark gray marine shale. Thickness about 250 feet.	Do.
	Kelvin Formation	Continental deposits, predominantly red colored. Thickness about 1,500 feet.	Not penetrated by wells in the study area, but supplies a few springs.
Jurassic	Morrison Formation	Continental deposits, locally containing abundant dinosaur remains. Thickness uncertain, perhaps as much as 1,200 feet.	Not known to yield water in the study area.
	Preuss Sandstone	Nonmarine siltstone and sandstone. Thickness probably more than 1,000 feet.	Yields small amounts of water to a few wells in the area. Insufficient data to estimate transmissivity.
	Twin Creek Limestone	Light-colored splintery limestone. Thickness as much as 2,000 feet.	Yields water to several wells and springs in the area, probably from fractures and solution cavities. Data suggest transmissivity of less than 135 $ft^3/d/ft$.
Jurassic(?) and Triassic(?)	Nugget Sandstone	Crossbedded eolian sandstone, generally some shade of red. Thickness as much as 1,200 feet.	Yields water to several wells in the area. Transmissivity generally low (about 65 $ft^3/d/ft$) but locally as high as 335 $ft^3/d/ft$.
Triassic	Chinle Formation	Mixed nonmarine sediments, generally red. Thickness uncertain, probably less than 500 feet.	Yields small amounts of water to wells in the Parleys Park area. Transmissivity probably less than 135 $ft^3/d/ft$.
	Shinarump Member of the Chinle Formation	Fluvial sandstone and conglomerate. Thickness about 100 feet in the study area.	Not known to yield water in the study area.
	Ankareh Formation	Chiefly red siltstone, sandstone, and shale. Thickness more than 1,000 feet.	Yields a little water to wells in the Parleys Park area from sandy beds. Insufficient data to estimate transmissivity.
	Thaynes Formation	Calcareous marine sediments. Thickness more than 2,000 feet.	Yields some water to a few wells and springs, largely from fractures and solution openings. Insufficient data to estimate transmissivity.
	Woodside Formation	Red siltstone, sandstone, and shale. Thickness about 500 feet.	Reportedly yields water to the mine tunnels in the Park City area from fractures.
Permian	Park City Formation	Limestone, phosphorite, cherty siltstone, and shale. Thickness about 1,500 feet.	Not tapped by wells in the study area, but reportedly yields some water in the Uinta Basin (Feltis, 1966).
	Diamond Creek Sandstone	Light-colored crossbedded sandstone. Thickness up to 1,000 feet. Present only in the extreme south end of the study area.	Neither of these two formations is sufficiently extensive in the study area to be important as aquifers. No wells in the area tap either formation, but a few small springs in the extreme south end of the area produce water from one or both of these formations.
	Kirkman Limestone	Dark-colored, brecciated, thin-bedded limestone. Thickness up to 1,600 feet. Present only in the extreme south end of the study area.	
Permian and Pennsylvanian	Oquirrh Formation	Interbedded sandstone and limestone containing some shale and siltstone. Thickness as much as 8,000 feet, but probably less in the study area. Present only south of Heber City.	Yields some water to wells and springs, chiefly from fractures and solution openings. Transmissivity estimated as about 270 $ft^3/d/ft$.

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Table 1.—Generalized stratigraphic summary of the consolidated rocks of the Heber-Kamas-Park City area—continued

Age	Formation	Lithology and thickness	Water-bearing properties
Pennsylvanian	Weber Quartzite	Chiefly gray crossbedded sandstone. Thickness up to 3,000 feet.	Yields small amounts of water to a few wells. Primary permeability is very low, but reportedly yields large quantities of water from fractures in the mine workings near Park City. Principal source of water in the mines.
	Morgan Formation	Red sandstone and shale interfingers with the Weber Quartzite in part. Thickness up to 1,000 feet.	No information on water-bearing properties in the study area, but primary permeability is probably low.
	Round Valley Limestone	Light-gray marine limestone. Thickness 250-400 feet.	No wells penetrate the formation in the study area, but it yields water to numerous springs.
Pennsylvanian and Mississippian	Manning Canyon Shale	Marine shale, siltstone, claystone, and limestone. Thickness 300-500 feet.	Not penetrated by wells in the area, but supplies a few small springs.
Mississippian and Devonian	Mississippian and Devonian rocks undivided	Chiefly marine limestones and dolomites. Thickness from 3,000 to 6,000 feet.	Not penetrated by wells in the area, but yields water from fractures and solution openings to many springs. A major aquifer.
Cambrian	Cambrian sedimentary rocks undivided	Chiefly shales and quartzites. Thickness uncertain, probably up to 3,000 feet.	Not known to yield water in the study area.
Precambrian	Precambrian rocks undivided	Chiefly metasediments. Thickness unknown.	Water-bearing potential unknown, but probably small.

Recharge

In most of the mountainous area, the soil cover is thin and permeable, and rain or snowmelt can infiltrate readily. The rapidity of infiltration into the rocks in the mountains is indicated by the reports that the discharge of the mine tunnels in the Park City area increases noticably during the period of spring snowmelt and runoff. Moreover, observation well (D-2-5)32bad-1, finished in the Tertiary volcanic rocks, shows small rises of water level only a few hours after a rainstorm over the area. The water level in one of the nonflowing thermal springs near Midway (see p. 21) also rises rapidly in response to rain or snowmelt in the mountains.

Movement

As has been indicated, water moves through the consolidated rocks readily, principally along the abundant zones of fracturing and solution openings. The direction of movement is, in general, downhill from recharge areas in the mountains to discharge areas near the margins of the valleys.

Whether any appreciable amount of water leaves the study area through the consolidated rocks is difficult to ascertain, but an unbalance of 17,000 acre-feet per year in the gound-water budget for Heber Valley is probably due to movement out of the valley through the consolidated rocks. The structural feature most commonly suspected of draining water from the area is the Charleston thrust fault, which passes entirely through the Wasatch Range. Deer Creek Reservoir, on the Provo River, lies directly across the outcrop of the Charleston and associated Deer Creek thrust fault (see pl. 2), and the water budget for Deer Creek Reservoir (see p. 8) indicates that there is no loss of water from the reservoir along the thrust planes. Because there is no detectable movement of water from Deer Creek Reservoir down the Charleston thrust fault, it is probable that no significant amount of ground water leaves the study area along the fault.

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Discharge

The principal manmade discharge of water from the consolidated rocks in the area is through the extensive mine workings in the vicinity of Park City (fig. 7). The amount of water discharged by the few small-capacity wells that penetrate the consolidated rocks is only a very small part of the total discharge. Natural discharge is through numerous springs, mostly around the margins of the valleys, and through direct infiltration into the unconsolidated deposits in the valleys.

The total discharge from mine tunnels is estimated as at least 50 cfs (cubic feet per second) or 36,000 acre-feet per year. The discharge of the Spiro Tunnel, near Park City, was reported in 1935 as about 15 cfs and "a rather steady flow" for several years (G. H. Taylor, written commun., 1935). The flow of Drain Tunnel Creek, which consists principally of the discharge of the Ontario No. 2 Drain Tunnel, is measured at a weir about 5 miles downstream from the mouth of the tunnel (fig. 2). The losses to evapotranspiration between the tunnel mouth and the weir probably equal or exceed any gains from ground-water discharge to the stream. The average discharge of Drain Tunnel Creek is 15.9 cfs (18 years of record). The drainage from the Mayflower Mine enters Drain Tunnel Creek downstream from the above-mentioned weir; in 1967-68 the discharge of the Mayflower Mine drainage was estimated as about one-half that of Drain Tunnel Creek at the weir. Smaller amounts of water are discharged from other tunnels in the area.

The water discharged from the Alliance Tunnel (quantity unknown) provides the municipal supply for Park City; the discharge from the other tunnels is used for irrigation in Parleys Park and Heber Valley.

A large but undetermined amount of water is discharged from the consolidated rocks through numerous springs. In 1968, the Utah State Engineer's records included claims to water from about 250 springs that discharge water from the consolidated rocks. The springs are nearly all associated with fractures or solution openings. The largest springs in the area flow from solution openings in the limestones of Pennsylvanian and Mississippian age. For example, three springs near the mouth of Snake Creek Canyon discharged about 13 cfs from the limestones during the summer of 1967.

An unusual hydrologic feature of Heber Valley is a group of thermal springs near the town of Midway. Although the springs are located on the Snake Creek alluvial fan, and are underlain in part by alluvium, their source is deep seated and they represent discharge from the consolidated rocks. A more detailed discussion of the thermal springs has been given elsewhere (Baker, 1968), and they will be described only briefly here.

Most of the thermal springs do not flow and are known locally as "hot pots." The typical hot pots are small pools of warm water that occupy shallow depressions in the tops of mounds of calcareous tufa (fig. 8). Seventeen hot pots in the area have been examined by the writer. Four of the hot pots are artificially discharged to supply water to swimming pools at resorts, 2 pots occasionally overflow, and the other 11 discharge water at the land surface only by evaporation, although some thermal water may be discharged into the valley fill in the subsurface.

The temperature of the water in the 13 pots without artificial discharge ranges from 12° to 34°C (54°-94°F), and the highest temperatures are in the 2 pots that occasionally overflow. Water temperature in the 4 pots that are artificially discharge ranges from 38° to 40°C (100°-104°F). Addition of heated water from below to many of the pots is very slow, and the water of a few pots is lower than that properly classified as "thermal."

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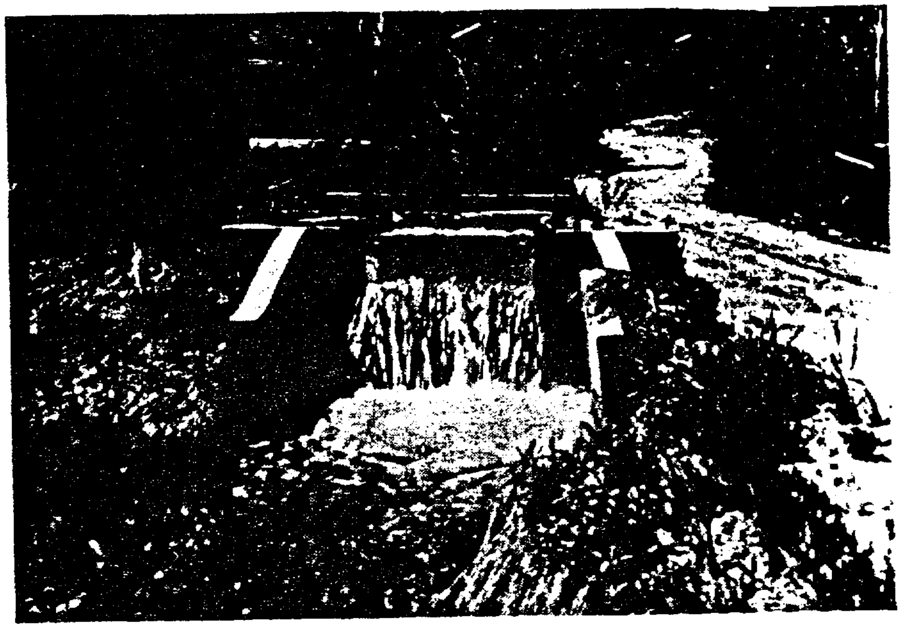

Figure 7.—Water discharging from the Spiro Tunnel near Park City. Water moves from the tunnel mouth to this drainage ditch through the pipe in the background. Discharge is about 15 cubic feet per second.

Figure 8.—Typical hot pot near Midway. View looking east from a point about 7 feet above the ground. The opening is about 9 feet in diameter and the top of the rim is about 5 feet above the road in the upper left corner of the photograph. Water level is about 1.5 feet below the rim.

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In addition to the hot pots, at least 7 thermal springs in the area flow perennially. The discharge of these springs ranges from a few gallons per minute to about 3 cfs; the total discharge of the 7 springs in 1967 was about 7 cfs. The water temperature of the 7 flowing springs ranges from 30° to 46°C (86°-144°F).

Chemical quality

Nearly all the nonthermal water from the consolidated rocks is suitable for domestic use according to the standards of the U. S. Public Health Service (1962); the exception is some water from the volcanic rocks that is high in iron. All the water is hard to very hard, and many residents of the area use ion-exchange type softeners in their domestic water systems. Water from the hot pots is too mineralized to be desirable for domestic use, and plentiful supplies of better water are available from the springs that furnish the public supply of Midway. Even water from the hot pots is used by livestock; and, according to the criteria established by the U. S. Department of Agriculture (U.S. Salinity Lab. Staff, 1954), all water from the consolidated rocks in the area is suitable to use for irrigation. Although water from the hot pots is in the high salinity hazard class for irrigation, it can be used for salt-tolerant crops on the premeable and well-drained soils in Heber Valley.

Samples of water for chemical analysis were collected from 28 springs, wells, and tunnels that tap the consolidated rocks; the analyses are included in table 5. The locations from which the samples were collected and diagrammatic representations of the concentrations of the principal dissolved solids in some of the samples are shown on plate 3. Four kinds of water can be distinguished from four general sources in the consolidated rocks. Figure 9 illustrates average analyses of samples of the four kinds of water.

Water from the sandstones and limestones of Jurassic age and older is represented by diagram 1 (fig. 9). The water is of calcium magnesium bicarbonate type and is not highly mineralized; the concentration of dissolved solids in 13 samples from these formations ranged from 104 to 488 mg/l. Most samples were hard according to the classification of the U. S. Geological Survey (more than 120 mg/l hardness), and many samples were in the very hard range (more than 180 mg/l). The concentration of silica was low; the samples ranged from 8.2 to 25 mg/l, but most were below 20 mg/l. The percentages of sulfate and chloride were low (each less than 20 percent of the total anions), and chloride was generally slightly lower than sulfate.

Diagram 2 (fig. 9) is typical of water from the shales of Triassic age; 1 sample was collected from a spring, 1 from a well, and 3 from mine drain tunnels. The water is of calcium sulfate type, and generally more concentrated than that from the limestones and sandstones. The concentration of dissolved solids in 5 samples ranged from 218 to 691 mg/l. All samples were in the very hard range; the hardness of 2 samples exceeded 300 mg/l. Concentrations of silica ranged from 6.3 to 21 mg/l.

Water from the volcanic rocks is represented by diagram 3 (fig. 9). The volcanic rocks yield calcium bicarbonate type water; the concentrations of 5 samples ranged from 249 to 1,020 mg/l. Four samples were in the very hard range, but water from the volcanic rocks was generally softer than water from the shales. Concentrations of silica were much higher in these samples than in water from other sources in the area. The silica concentration ranged from 22 to 52 mg/l, but only 1 sample was below 30 mg/l. The relative concentrations of sulfate and chloride in these waters was also distinctive; the samples contained from 3 to 5 times as much chloride as sulfate. The volcanic rocks are the only consolidated rocks in the area that yield water containing

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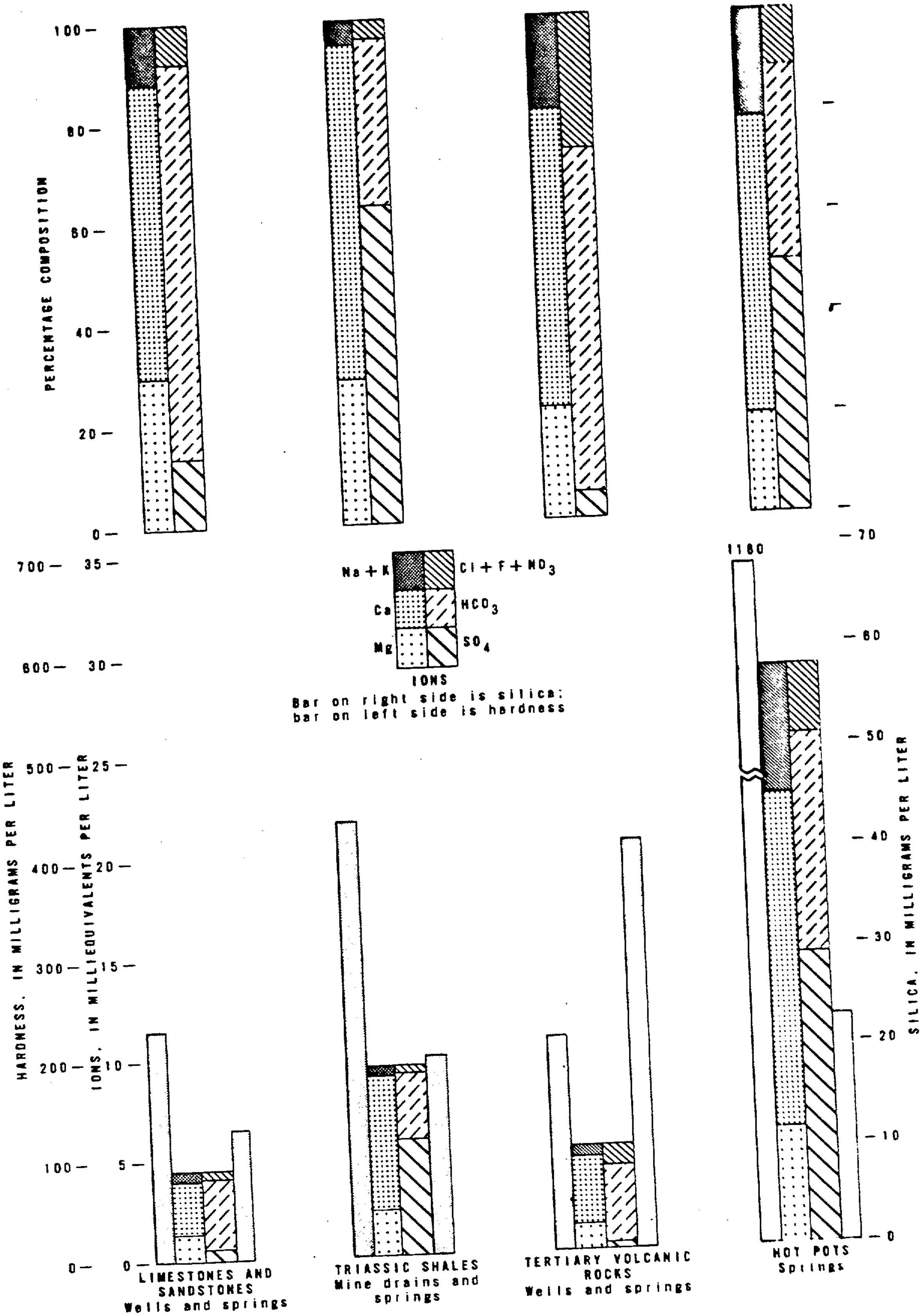

Figure 9.—Diagrams illustrating differences in quality of water from various sources in the consolidated rocks.

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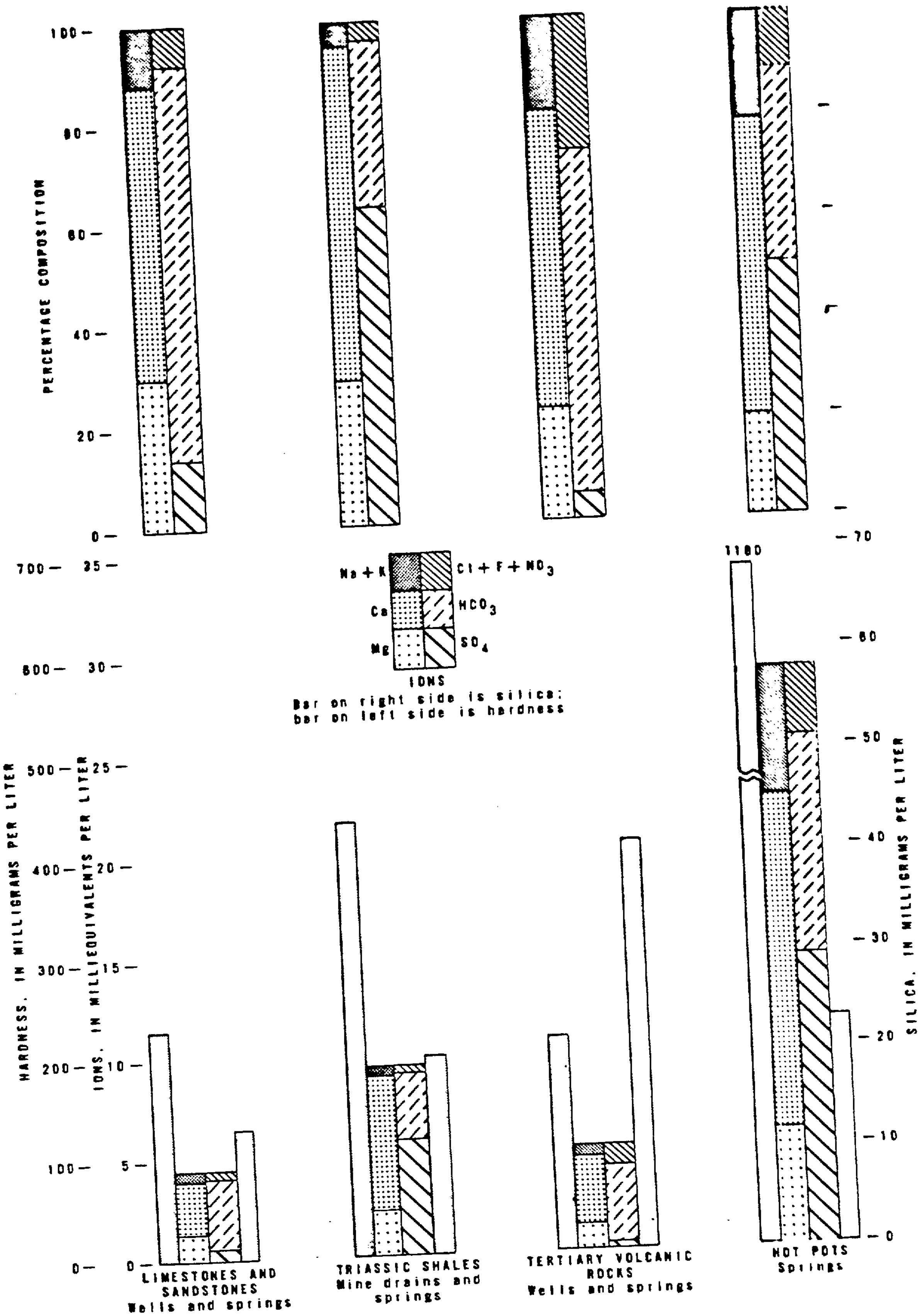

Figure 9.—Diagrams illustrating differences in quality of water from various sources in the consolidated rocks.

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substantially more chloride than sulfate. One sample was very high in iron (34 mg/l), but this seems to be a local condition; the few other analyses indicate little or no iron in solution.

Water from the hot pots is a calcium sulfate bicarbonate type (diagram 4, fig. 9), and is by far the most mineralized water in the area. Concentrations of dissolved solids in 10 samples of the thermal water ranged from 1,650 to 2,160 mg/l, and total hardness ranged from 960 to 1,270 mg/l. The water is saturated with respect to calcium carbonate at normal temperatures and pressures; calcium carbonate precipitates from samples that are allowed to stand for a few days exposed to the atmosphere.

Ground water in the unconsolidated deposits

The principal source of water to wells in the Heber-Kamas-Park City area is the unconsolidated alluvial fill in the major valleys. Unconsolidated deposits in the mountains have little significance as aquifers. The stratigraphy, lithology, and water-bearing characteristics of the unconsolidated deposits are summarized in table 2. The areal distribution of the various units is shown on plate 2.

Table 2.—Generalized description of the unconsolidated deposits in the Heber-Kamas-Park City area

Age	Unit	Lithology and thickness	Water-bearing properties
Quaternary	Younger alluvium	Poorly sorted mixture of material ranging in size from clay to boulders. All beds appear to be lenticular and discontinuous. Thickness ranges from 0 to about 1,000 feet. Underlies the valley floors of Heber Valley, Rhodes Valley, Parleys Park, and Round Valley and forms low terraces along the margins of Heber and Rhodes Valleys. The two units cannot be distinguished lithologically; the terraces are mapped as older alluvium and the valley floors as younger alluvium, but older alluvium probably also underlies the valley floors.	These deposits form the best and most productive aquifers in the study area. Water-table conditions predominate. Hydraulic conductivity ranges from 20 to 50 $ft^3/d/ft^2$; estimated specific yield ranges from 12 to 15 percent. Most wells and many springs in the study area yield water from these deposits.
	Older alluvium		
	Landslide deposits	Unsorted material ranging from clay through boulders. Thickness unknown. Present only in a few isolated areas of the mountains.	Hydrologic properties unknown, but the scattered small deposits have no hydrologic significance in the area.
	Glacial deposits	Includes outwash deposits, morainal deposits, and glacially striated bare ground. Present in the higher elevations of both the Wasatch Range and the Uinta Mountains.	The small areas of sorted outwash undoubtedly store and transmit some ground water, but the glacial deposits as a whole have no significance as aquifers in the study area.
Tertiary(?)	Older high-level gravel surfaces of uncertain age	Planed surfaces underlain by thin deposits of gravel. Thickness uncertain. Present only in southeastern part of study area.	No data concerning hydrologic characteristics, but not significant as an aquifer in the study area.

Heber Valley

Heber Valley, on the Provo River, is the largest of the four valleys included in the study area (pl. 1 and fig. 1). The valley floor is roughly triangular in plan and has an area of about 44 square miles. The Provo River enters the valley at the northern apex of the triangle and flows out near the southwestern apex. Three small tributaries of the Provo River—Lake, Center, and Daniels Creeks—enter the valley near the southeastern apex, and a fourth tributary, Snake Creek, enters about midway on the western side of the valley. The valley floor is thickly blanketed with unconsolidated debris, and each of the tributary streams has built a substantial alluvial fan at the mouth of its canyon.

Two wells in Heber Valley that pass through the entire thickness of unconsolidated material reached consolidated rocks at depths of about 310 feet. Geophysical studies, however, Ay1

indicate that the maximum thickness of the unconsolidated deposits may exceed 800 feet locally (see appendix, p. 57). The material is poorly sorted, and because there are no well-defined beds of material of very low or very high permeability, the unconsolidated valley fill can be treated as a single, essentially homogeneous, water-table aquifer.

Aquifer characteristics.—The calculated hydraulic conductivity of the aquifer in Heber Valley is about 50 $ft^3/day/ft^2$ (cubic feet of water per day per square foot), and the transmissivity is in the range of 6,700-20,000 $ft^3/day/ft$. These values were calculated using values of specific capacity of wells obtained from drillers' tests and using the value for ground-water accretion to Deer Creek Reservoir calculated on page 8. Conventional aquifer tests were not made because the valley contains no large-capacity wells.

Drillers' reports for 35 wells in the valley include the results of pumping or bailing tests, generally of 2 hours duration or less (table 3). The specific capacities determined from these tests ranged from 0.2 to 25 gpm (gallons per minute) per foot of drawdown. Because the specific capacity of a well is greatly influenced by the well construction—thickness of aquifer penetrated and open to the well, method of finish, method and amount of development, and a host of other factors—as well as the duration of the test, the largest specific capacities are probably most indicative of the potential of the aquifer. The largest specific capacities of wells in Heber Valley (25 gpm per foot of drawdown) were used to calculate the aquifer transmisivity by the method of Theis and others (1963); the calculated transmissivity was about 6,700 $ft^3/day/ft$.

The calculated ground-water accretion to Deer Creek Reservoir is 47,000 acre-feet per year (p. 8). Using Darcy's law in the form:

$$T = 119.4\ Q/IL$$

where Q is the ground-water discharge (47,000 acre-feet per year), I is the slope of the water table near the reservoir (0.02 foot per foot), and L is the length of the reservoir shoreline adjacent to the valley fill (13,900 feet), the transmissivity, T, is calculated as about 20,000 $ft^3/day/ft$.

The specific yield of the aquifer material was estimated from drillers' logs as follows: Each logged material was assigned a value of specific yield and this value was multiplied by the percent of the total depth logged as that material; the resulting figure was the weighted specific yield for the given material in that hole. The weighted specific yields of all the materials reported in each log were summed to give the average specific yield of all the material drilled. The values of specific yield assigned to the various materials reported by the drillers were values that have been determined largely by hydrologists in other areas and the interpretation of drillers' terms followed the schemes summarized by Johnson (1967, tables 17 and 24).

The specific yield of the upper 30 feet of the aquifer material was estimated from 20 logs; the values of specific yield ranged from 8 to 20 percent and averaged about 14 percent. The specific yield of the total thickness of material penetrated was estimated from 17 logs of the deepest wells in the valley. The total depths of the wells ranged from 100 to 225 feet and averaged 144 feet; the values of specific yield ranged from 7 to 21 percent and averaged about 12 percent. Accordingly, the value of 14 percent (for the upper 30 feet of the material) was used to compute annual recharge, and the value of 12 percent (for the total thickness of the valley fill) was used to compute the amount of water in recoverable storage in the aquifer.

Ground-water budget.—The ground-water budget for the valley fill in Heber Valley is summarized as follows:

	Acre-feet
Recharge:	
Irrigation water and precipitation on the valley floor	56,000
Subsurface inflow	30,000
Total recharge:	86,000
Discharge:	
Net evapotranspiration loss (evapotranspiration less precipitation)	11,000
To Deer Creek Reservoir	47,000
To Provo River	11,000
Subsurface outflow	17,000
Total discharge:	86,000

The derivation of each of these values is explained in the following sections on recharge and discharge.

In the calculations of recharge and discharge (both in Heber Valley and in Rhodes Valley) the assumption is made that precipitation on the valley floor is entirely consumed by evapotranspiration. This assumption is, of course, an oversimplification; some of the precipitation reaches the water table as recharge and some runs off as surface water. The calculated totals for both recharge and discharge are not affected by the simplification.

Recharge.—The unconsolidated deposits in Heber Valley are recharged by precipitation on the valley floor; by infiltration of surface water, especially water spread over the land for irrigation; and by subsurface inflow from the surrounding consolidated rocks. The amount of recharge derived from the infiltration of precipitation is small and probably occurs primarily during the spring period of snowmelt. Direct infiltration of water from the Provo River is also small; most of the time the Provo River through Heber Valley is a gaining stream and removes water from the aquifer rather than adding water to it.

The infiltration of irrigation water is the major source of recharge to the valley fill. Most of the valley bottom is irrigated, and because the infiltration rate is rapid, each application of irrigation water adds considerable recharge to the aquifer.

The average annual recharge in Heber Valley is somewhat more than the average annual change in storage, but the difference between annual change in storage and annual recharge

Ref 1

probably is not great. Hence, the average annual change in storage can be used as the budget estimate for average annual recharge.

The average annual change in storage in the water-table aquifer is equal to the product of the annual change in saturated thickness, the specific yield of the aquifer material, and the area of the aquifer.

Water levels in about 25 wells in all parts of Heber Valley were measured by various agencies, and were reported by the Provo River Commissioner, during the period 1945-60. The Commissioners' reports distinguish four subareas or divisions of the valley. The four divisions, their approximate areas, and the average annual change of saturated thickness in each division for the period 1945-60 (from the Provo River Commissioners' Annual Reports) are tabulated below:

Division	Area (acres)	Average annual change in saturated thickness (feet)
Above irrigation	3,000	4.97
Midvalley	21,000	25.58
Lower valley	3,200	13.52
River bottom lands	800	7.58

The estimated average specific yield of the upper 30 feet of the aquifer materials is 14 percent; if that estimate and the tabulated figures are used in the equation, the computed average annual change in storage in the unconsolidated deposits in Heber Valley is 86,000 acre-feet.

The principal sources of recharge to the valley fill, as stated earlier, are infiltration of irrigation water and subsurface inflow from the consolidated rocks. Neglecting minor sources of recharge, the approximate contribution from each of the principal sources can be calculated from the following data:

The total amount of water diverted for irrigation in Heber Valley each year is reported by the Provo River Commissioner; the average for the period 1945-60 was 87,000 acre-feet per year.

The average amount of water required by crops in the valley during the irrigation season (May-September) can be calculated by the Blaney-Criddle method (Blaney and Criddle, 1962). Using data published by the Utah State Engineer's office (Criddle and others, 1962) for hay and mixed pastures in Heber Valley, the crop water requirement is calculated as 43,000 acre-feet per irrigation season.

Part of the water required by the crops will be furnished by precipitation during the growing season. Using data from the May-September precipitation map of Utah (U. S. Weather Bur., 1963), the precipitation on the valley floor during the irrigation season is calculated as 12,000 acre-feet.

Ref 1

So the contribution to recharge, in acre-feet, from irrigation is:

Water diverted for irrigation	87,000
Plus precipitation	+12,000
Total:	99,000
Less crop water requirements	−43,000
Difference (available for recharge):	56,000

And the contribution from subsurface inflow, in acre-feet, is:

Total recharge	86,000
Less recharge from irrigation	−56,000
Difference (recharge from subsurface inflow):	30,000

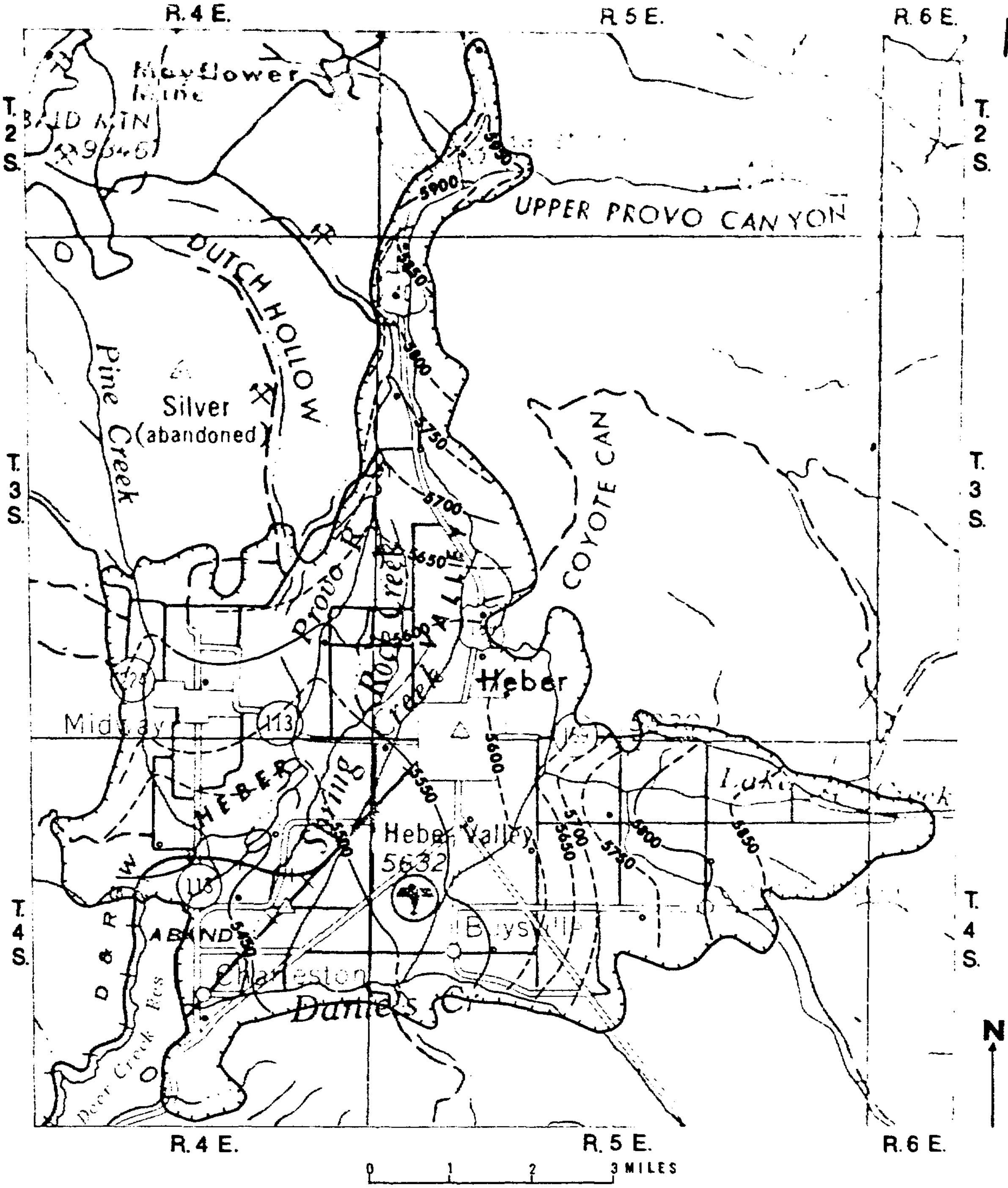
Movement.—The direction of ground-water movement through the unconsolidated deposits in Heber Valley is shown by the water-table map (fig. 10). In general, the direction of movement is toward the Provo River and downvalley. During periods of peak stream discharge, the direction of movement in the immediate vicinity of the river probably would be reversed.

The water-table map indicates that Snake Creek, like the Provo River, is generally a gaining stream in Heber Valley. The three tributaries from the east (Lake, Center, and Daniels Creeks), however, are losing streams. The coarse-grained fan deposits across which these streams flow as they enter the valley are at altitudes well above the main valley floor, and the water table is several tens of feet below the surface of the fans (fig. 11). The increased depth to water in the area of these alluvial fans reflects the higher altitude of the land surface; the slope of the water table beneath the fans is about the same as the slope of the water table elsewhere in the valley (fig. 10).

Water-level fluctuations.—The water level in wells in Heber Valley fluctuates in response to the seasonal recharge-discharge cycle (figs. 11 and 12 and table 7). Generally the water table is highest in late May or early June and gradually declines through the summer, fall, and winter. The lowest level of the year is commonly reached in February or March, shortly before the spring thaw. With the coming of the thaw and the heavy spring runoff, the water table rises rapidly, and again reaches a high in May or June. This seasonal rise and fall of the water level is illustrated by the graph of well (D-4-4)14abb-1 (fig. 12).

Man's activities have somewhat altered the cycle in Heber Valley. One effect is the intermittent addition of recharge by irrigation during the growing season. In well (D-4-4)23bcc-1 (fig. 13), the smooth summer decline of the water level is interrupted by many small but rapid rises, each resulting from the rapid infiltration of irrigation water applied to nearby fields. A second effect of man's activities is shown by the same graph—near Deer Creek Reservoir the water level in the aquifer is controlled by the water level in the reservoir (fig. 13). Except for the minor fluctuations from irrigation during the growing season, the graph of the water level in the well is a subdued image of the graph of the water level in the reservoir.

Comparison of the long-term graphs with the graph of departure from normal precipitation at Heber (fig. 12) shows that the aquifer is in a state of equilibrium, with recharge



Base from U.S. Geological Survey 1:250,000 (AMS) series: Salt Lake City, Utah; Wyoming (1963)

EXPLANATION

5600

Water-level contour

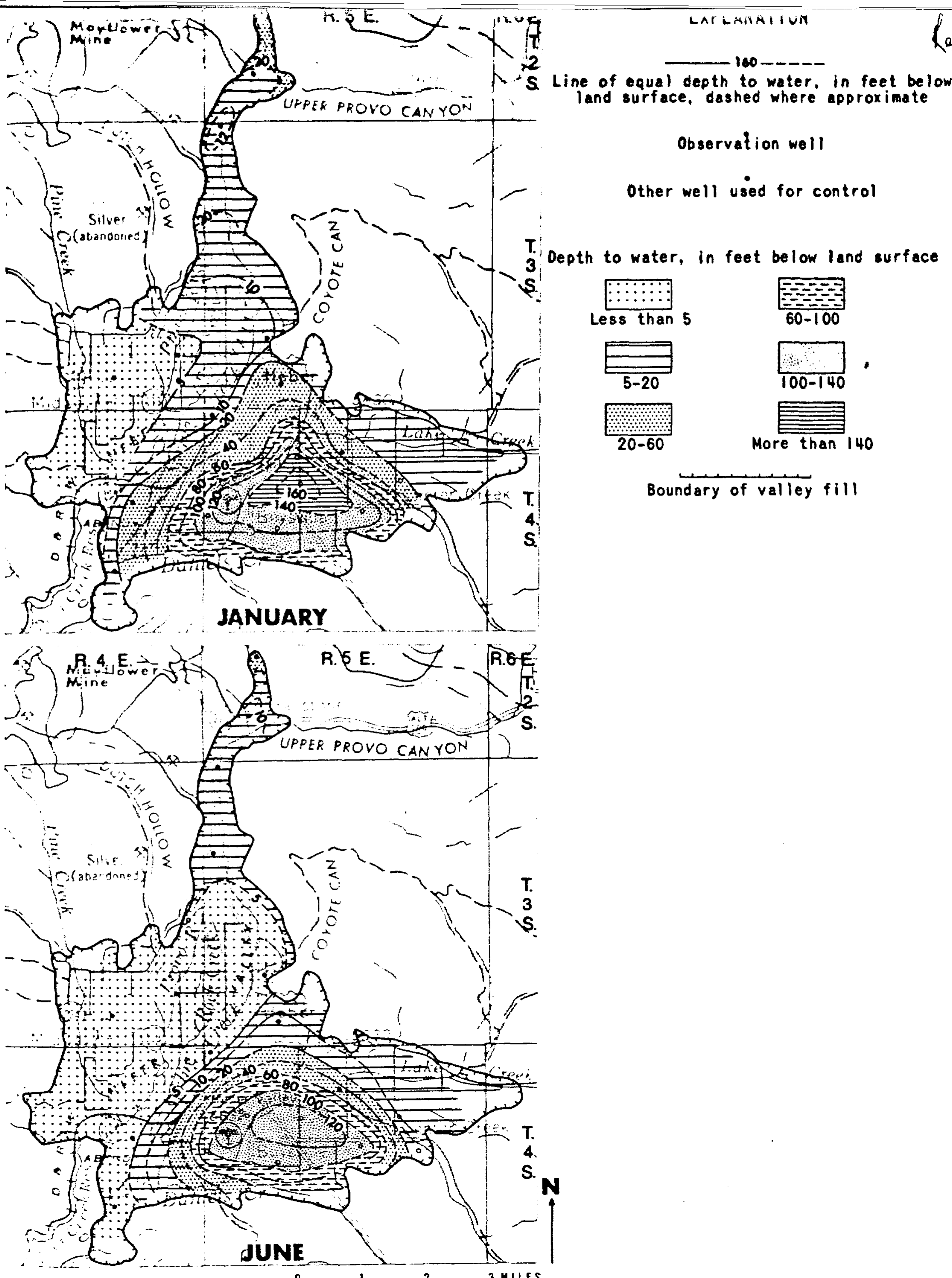
Dashed where approximate. Contour interval 50 feet. Datum is mean sea level

Observation well

Other well used for control

Boundary of valley fill

Figure 10.—Map of Heber Valley showing water-level contours in September 1967.



Base from U.S. Geological Survey 1:250,000 (AMS) series: Salt Lake City, Utah; Wyoming (1963)

Figure 11.—Maps of Heber Valley showing depths to water in January 1967 (near seasonal low) and June 1967 (near seasonal high).

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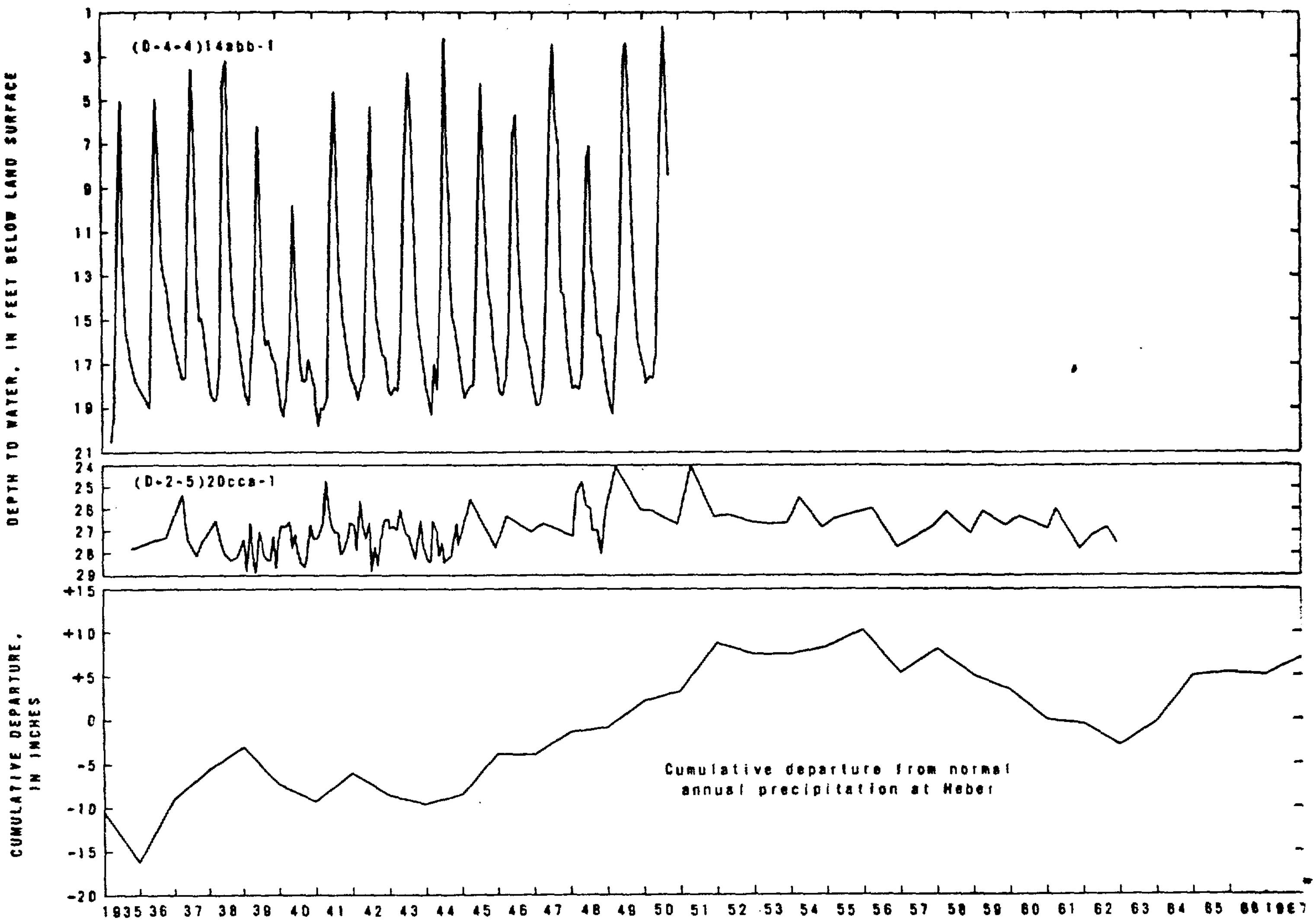

Figure 12.—Water levels in selected wells in Heber Valley and cumulative departure from the 1931-60 normal annual precipitation at Heber.

about balanced by discharge. Very wet or very dry years are reflected by unusually high or low water levels, but the peaks of each graph cluster about an average line, and there is no indication of a significant long-term change in water levels in Heber Valley.

Storage.—The total volume of water in storage in an aquifer can be calculated by multiplying the total volume of the aquifer by the total porosity of the aquifer material, but such a figure is of little value, because part of the water in an aquifer is held tightly by molecular forces and cannot be recovered. The recoverable water in storage, that is, the volume of water that can be removed from storage by wells, is equal to the product of the volume of the aquifer and the specific yield of the aquifer materials. It is difficult to get an accurate estimate of the total volume of alluvial fill in a valley, but the volume of water theoretically recoverable from the upper 100 feet of the aquifer can be calculated.

Available information on the thickness of the valley fill in Heber Valley indicates that it extends at least 50 feet below the water table under most of the valley and at least 100 feet

Ref'

below the water table under at least two-thirds of the valley. The average specific yield of the aquifer material to a depth of 100 feet is estimated as 12 percent. Using these figures, the volume of water theoretically recoverable from dewatering 100 feet of the unconsolidated deposits in Heber Valley is calculated thus:

28,000 acres x 50 feet x 12 percent = 170,000 acre-feet (approximately) for the upper 50 feet and;

28,000 acres x 50 feet x 0.66 x 12 percent = 110,000 acre-feet (approximately) for the next 50 feet;

total 170,000 + 110,000 = 280,000 acre-feet.

The statement that 280,000 acre-feet of water is theoretically recoverable from the upper 100 feet of valley fill in Heber Valley should not be construed to mean that it is practicable, under present conditions, to recover all, or any substantial part, of that amount. The calculated 280,000 acre-feet of water could be removed only by dewatering the upper 100 feet of the aquifer. However, the ground water in the valley fill and the surface water in the Provo River and its tributaries are two parts of a system that is presently in dynamic equilibrium. Efforts to dewater any part of the aquifer would, of course, upset that equilibrium, and would have far-reaching effects on the system. This point is discussed in greater detail on pages 46-47.

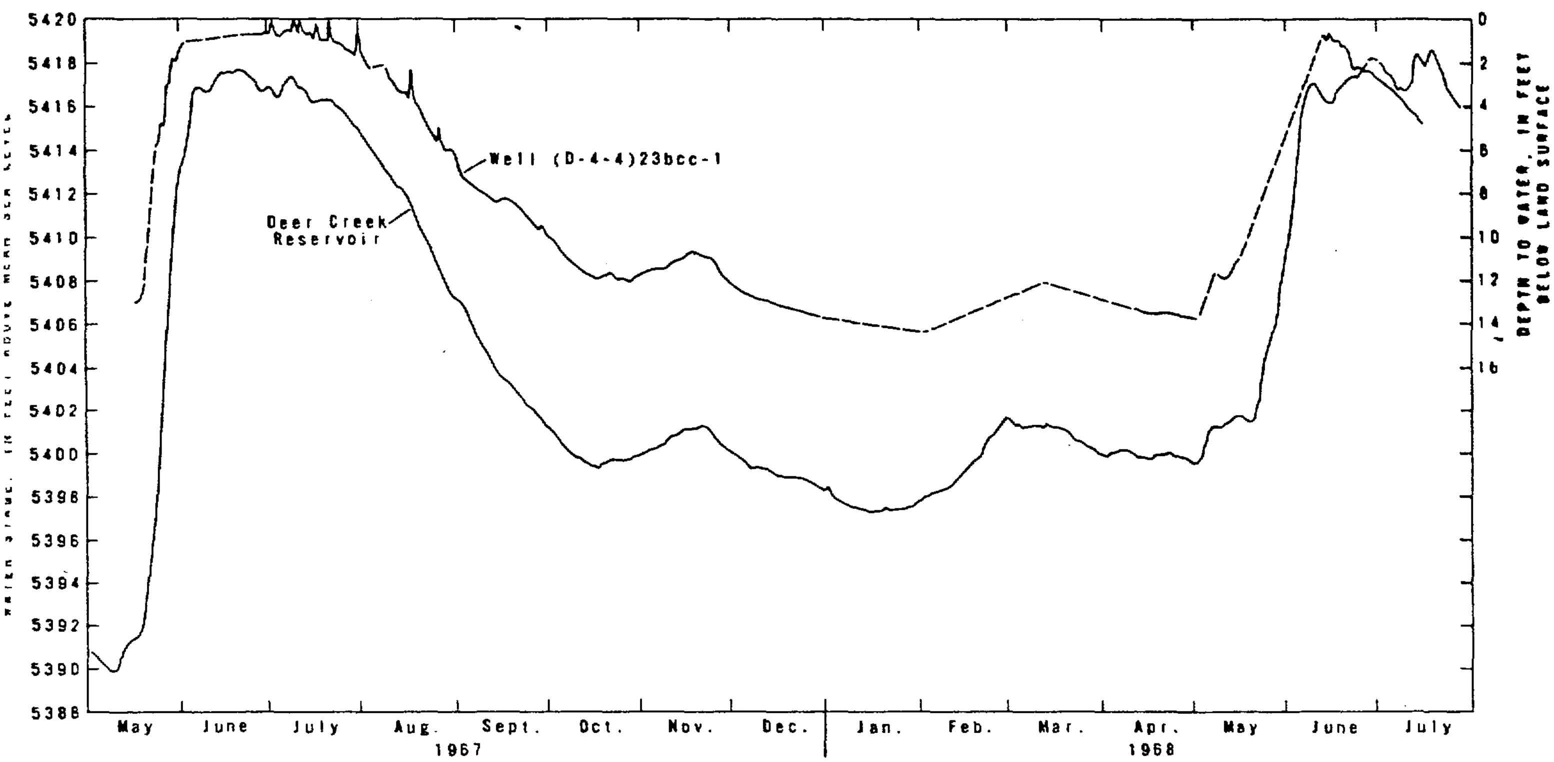

Figure 13.—Water levels in well (D-4-4)23bcc-1, near the south end of Heber Valley, and water stage in Deer Creek Reservoir.

Ref 1

Discharge.—Ground water is discharged from the unconsolidated deposits in Heber Valley by pumping from wells, by evapotranspiration, by effluent seepage, and probably by subsurface outflow through the surrounding consolidated rocks.

The total volume of water pumped from wells in the valley is very small, and there have been no drastic changes in irrigation practice for many years; hence the long-term recharge-discharge regimen is fairly stable and should be in balance. The average annual discharge, therefore, should be about 86,000 acre-feet per year.

The total evapotranspiration from Heber Valley, calculated by the Blaney-Criddle method (Blaney and Criddle, 1962) is about 81,000 acre-feet per year. (evaporation from Deer Creek Reservoir is not included in this amount). Part of the evapotranspiration loss is the crop water requirement and is supplied by irrigation water and summer precipitation (p. 28); and according to the assumption made on page 27, part of the loss will be supplied by the winter precipitation. The net evapotranspiration loss from the ground-water body, therefore, is calculated as follows:

	Acre-feet
Total evapotranspiration	81,000
Less crop water requirement (irrigation water and May-September precipitation)	−43,000
Less October-April precipitation	−27,000
Net evapotranspiration loss of ground water	11,000

Ground-water discharge by effluent seepage includes the accretion to Deer Creek Reservoir (47,000 acre-feet per year, p. 8) and the discharge to the Provo River (11,000 acre-feet per year, p. 12). Ground-water discharge to the Provo River apparently occurs throughout the length of the river in the valley.

The total discharge from the foregoing calculations is 69,000 acre-feet per year, or 17,000 acre-feet less than the average annual recharge. No direct evidence of subsurface discharge from the valley fill has been found, but this unbalance in the recharge-discharge calculation may indicate such subsurface discharge.

Thus the average annual discharge, in acre-feet, from the unconsolidated deposits is:

Net evapotranspiration loss	11,000
To Deer Creek Reservoir	47,000
To Provo River	11,000
Subsurface outflow	17,000
Total discharge	86,000

Ref 1

Chemical Quality.—All the water sampled from the unconsolidated deposits in Heber Valley was chemically suitable for domestic use, according to the standards of the U. S. Public Health Service, although 2 samples of sulfate type water and 1 sample of mixed type were somewhat above the optimum in dissolved solids, and all samples were hard to very hard. The water is satisfactory for stock or for irrigation.

Chemical analyses of 10 samples of water from the unconsolidated deposits in Heber Valley are reported in table 5. The locations from which the samples were collected and diagrammatic representations of the concentrations of the principal dissolved solids in some of the samples are shown on plate 3.

Seven of the 10 samples were calcium bicarbonate type water, with dissolved solids ranging from 187 to 446 mg/l. The hardness of the 7 samples ranged from 144 to 324 mg/l, in the hard to very hard range. Silica concentration ranged from 12 to 43 mg/l; the samples that were high in silica came from the east side of the valley, where the rocks forming the valley wall are predominantly volcanic.

Two of the 10 samples were calcium sulfate water, and both contained more dissolved solids than the calcium bicarbonate water. One of these samples came from a well at the north end of the valley, very near the outcropping of the Triassic shales, and the water was similar to that found in the shales (diagram 2, fig. 9). The concentration of dissolved solids of this sample was 727 mg/l and the hardness was 464 mg/l. The other sample of sulfate type water came from a well near Midway. That well taps a layer of gravel overlain by tufa, and the water is similar to water from the hot pots, but more dilute. The sample contained 1,160 mg/l dissolved solids, and the hardness was 770 mg/l.

One of the 10 samples was a calcium bicarbonate sulfate type water. That sample came from a shallow dug well in the tufa deposits near Midway, and the water appears to be a mixture of hot pot type water and the dilute calcium bicarbonate type water commonly found in the valley fill. The concentration of dissolved solids in the sample was 661 mg/l and the hardness was 434 mg/l.

Rhodes Valley

Rhodes Valley, the second largest of the four valleys in the study area, is nearly rectangular in plan, with the long axis of the rectangle oriented about north-south (pl. 1 and fig. 1). The area of the valley floor is about 39 square miles. The Weber River flows westward across the north end of the valley, entering and leaving through narrow canyons. The principal drainage of the valley is by Beaver Creek, which enters the valley from the east near the south end, flows northwestward, and joins the Weber River where that stream leaves the valley. At the south end, Rhodes Valley terminates in a bluff that overlooks the Provo River.

The alluvial fill deposited in Rhodes Valley by the Provo River (see p. 5-7) is probably more than 300 feet thick under most of the valley. In addition, a sizeable alluvial fan has been formed where the Weber River enters the valley, and smaller fans mark the mouths of Beaver Creek Canyon and Hoyt Canyon.

When the upper Provo River changed course, the stream entrenched itself in its former valley floor. Thus nearly 100 feet of unconsolidated material is exposed in the north side of the Provo Canyon at the south end of Rhodes Valley (fig. 14a). The material is poorly sorted and only weakly stratified (fig. 14b).

Ref¹

Total evapotranspiration (Blaney-Criddle method)	72,000
Less crop water requirement (irrigation and May-September precipitation, from page 37)	−40,000
Less October-April precipitation from precipitation map, pl. 2)	−22,000
Net evapotranspiration loss of ground water:	10,000

Long-term discharge records of the streams traversing the valley, from which ground-water discharge by effluent seepage could be calculated, are not available. Most of the valley bottom bordering Beaver Creek is marshy and contains abundant springs and seeps; most of the ground-water discharge to streams probably goes to Beaver Creek. A few springs are found in the bluff overlooking the Provo River, and the Provo is generally a gaining stream in the reach between the gaging stations near Woodland and near Hailstone (p. 10). The estimated minimum average annual discharge to Beaver Creek, Weber River, and Provo River is 12,000 acre-feet per year.

Chemical quality.—Chemical analyses of two samples of water from wells that tap the unconsolidated deposits in Rhodes Valley are reported in table 5. Both samples were dilute calcium bicarbonate type water. One sample, from a well near the south end of the valley and very near an outcropping of the Tertiary volcanic rocks, contained 289 mg/l dissolved solids. This water was relatively high in silica (40 mg/l) and contained about equal concentrations of sulfate and chloride (14 and 13 mg/l, respectively). The water is evidently affected by recharge from the nearby volcanic rocks.

The second sample of water was from a well near the north end of the valley, distant from the volcanic rocks. This water contained 205 mg/l of dissolved solids, was low in silica (5.5 mg/l), and contained about four times as much sulfate as chloride (13 and 3.9 mg/l, respectively). Subsurface recharge that affects this water comes from the sandstones and limestones of Jurassic age and older.

These two samples are probably typical of the water from the unconsolidated deposits in Rhodes Valley. The water, although hard, is quite suitable for domestic, livestock, and irrigation use.

Parleys Park

Parleys Park is the name given to the broad, gently rolling flat north of Park City (see pl. 1 and fig. 1). A ridge of low hills, extending east-northeast from Quarry Mountain, divides the south end of the park into two arms. The narrow eastern arm is the valley of Silver Creek, which heads in Empire Canyon south of Park City, flows around the east side of Quarry Mountain, continues northeast, and joins the Weber River about 2 miles north of Wanship Dam. The wider western arm and the broad flat north and west of the hills drains to East Canyon Creek. East Canyon Creek rises in the mountains north of Parleys Park and flows through the northern part of the park, collecting the water of several small streams that flow generally northward through the park. The creek then turns northward through a narrow canyon and joins the Weber River about 20 miles north of Parleys Park.

Ref 1

Unconsolidated deposits cover only about 21 square miles of Parleys Park along Silver and East Canyon Creeks and in the flats northwest of Quarry Mountain (pl. 2); the rest of the park is underlain by consolidated rocks, principally the Tertiary volcanic rocks and the Knight Conglomerate. Little information is available about the thickness of the unconsolidated deposits. The contact between the unconsolidated material and the underlying volcanic rocks or Knight Conglomerate is difficult to recognize in boreholes, and drillers often fail to recognize the contact. The differences in density between the unconsolidated deposits and the underlying material are too small to give conclusive results by gravity methods. The best information available suggests a maximum thickness of about 100 feet and an average thickness of about 60 feet.

The unconsolidated deposits in Parleys Park, as in Heber Valley and Rhodes Valley, consist of a poorly sorted mixture of material ranging in size from clay to cobbles. There appear to be no well-defined beds of material of very high or very low permeability, and no indications of the existence of artesian conditions. The unconsolidated deposits are saturated to within a few feet of the land surface with unconfined ground water.

There are very few wells in the unconsolidated deposits of Parleys Park to provide a basis for estimating the transmissivity and specific yield of the aquifer. The specific capacity of one well is reported as 20 gpm per foot of drawdown; such a specific capacity suggests an aquifer transmissivity of about 4,670 $ft^3/d/ft$. The aquifer at the well location is about 100 feet thick, giving an estimated hydraulic conductivity of about 50 $ft^3/d/ft^2$—about the same as the value derived for similar material in Heber Valley. The few drillers' logs available are not suitable for calculating specific yield by the method used in Heber Valley and Rhodes Valley; however, an estimate of 15 percent, based on the values derived in the other areas, is probably in the right range.

Recharge to the unconsolidated deposits in Parleys Park comes primarily from the direct infiltration of precipitation on the park and runoff from the surrounding mountains, and secondarily from subsurface inflow through the consolidated rocks. Available data on the annual range of water-level fluctuations are too scanty to permit a direct estimate of the average annual recharge. The probable minimum recharge is indicated by the estimated evapotranspiration (see below).

The inferred direction of ground-water movement in Parleys Park is shown in figure 17. Water in the eastern arm of the park moves toward Silver Creek and down the valley. In the western arm of the park, ground water moves generally northward toward East Canyon Creek. Each of the small tributaries of East Canyon Creek that crosses the park is a gaining stream, however, and locally ground water moves toward each of these streams.

The water-level fluctuations in well (D-1-4)31bdb-1 were observed from 1936 to 1948; the well was destroyed in 1948. Well (D-1-4)31adb-1 was monitered by an automatic water-level recorder that was installed in October 1966 and operated intermittently through 1968. Graphs of water levels in these wells are shown in figure 18. The short-term record of well (D-I-4)31adb-1 shows annual fluctuations of more than 17 feet, but the longer record of well (D-I-4)31bdb-1 shows no substantial long-term change in the position of the water table.

Any calculation of the amount of water available from storage in the unconsolidated deposits of Parleys Park can be only a rough estimate. The maximum depth to water recorded in well (D-1-4)31adb-1 was nearly 20 feet; if the average thickness of the unconsolidated deposits is 60 feet, the average saturated thickness (when the water table is lowest) is about 40 feet. If the

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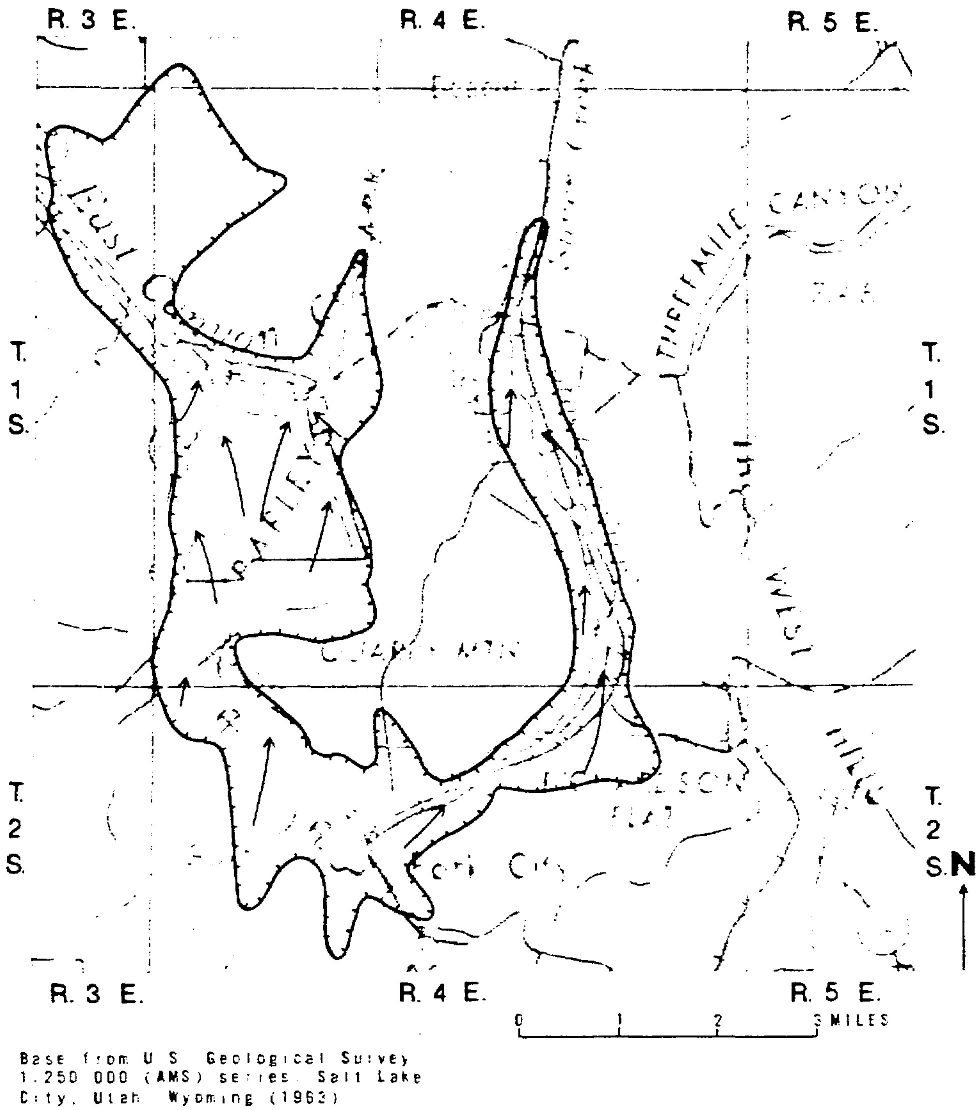

EXPLANATION

Approximate direction of ground-water movement

Boundary of unconsolidated deposits

Figure 17.—Map of Parleys Park showing approximate direction of ground-water movement through the unconsolidated deposits.

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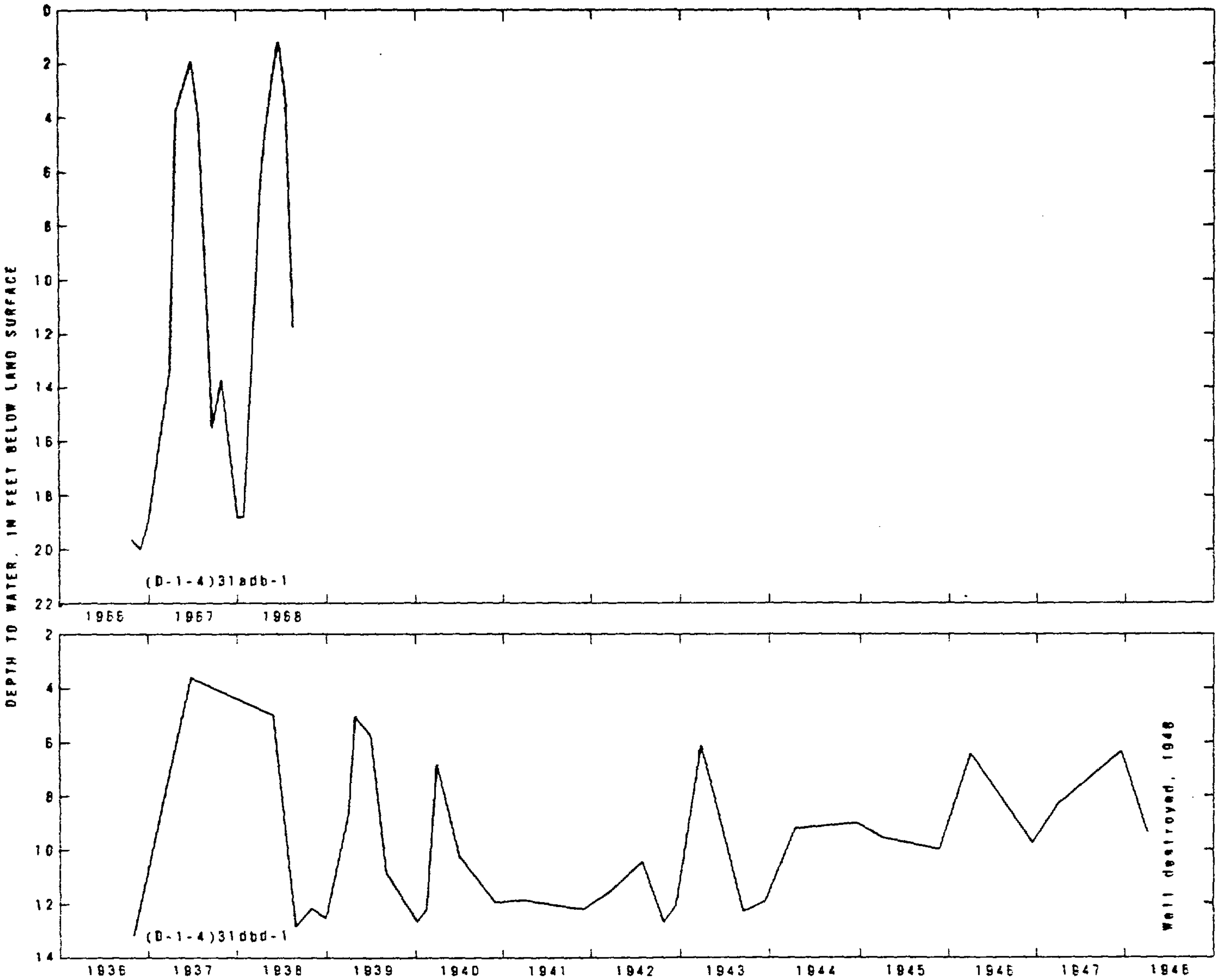

Figure 18.—Graphs of water levels in wells tapping the unconsolidated deposits in Parleys Park.

saturated thickness is 40 feet, the area 21 square miles (about 13,000 acres), and the specific yield 15 percent, the volume of recoverable water in storage is about 80,000 acre-feet. As in the other calculations of storage, this volume of water is theoretically recoverable by dewatering the aquifer; dewatering the aquifer, however, may not be practicable in the foreseeable future.

The combined discharge from wells and discrete springs in the unconsolidated deposits in Parleys Park is small. Large seeps or marshy areas are common in the park, however, especially during the summer months; and these areas discharge large quantities of ground water by evapotranspiration. The total evapotranspiration from the park is calculated by the Blaney-Criddle method as 43,000 acre-feet per year based on air temperatures measured at Park City during the period 1921-50. Ground water is also discharged directly to Silver Creek and to East Canyon Creek and its tributaries; all the streams in the park appear to be gaining streams most of the year. It is possible that water also moves from the unconsolidated deposits into the consolidated rocks at the north end of the park.

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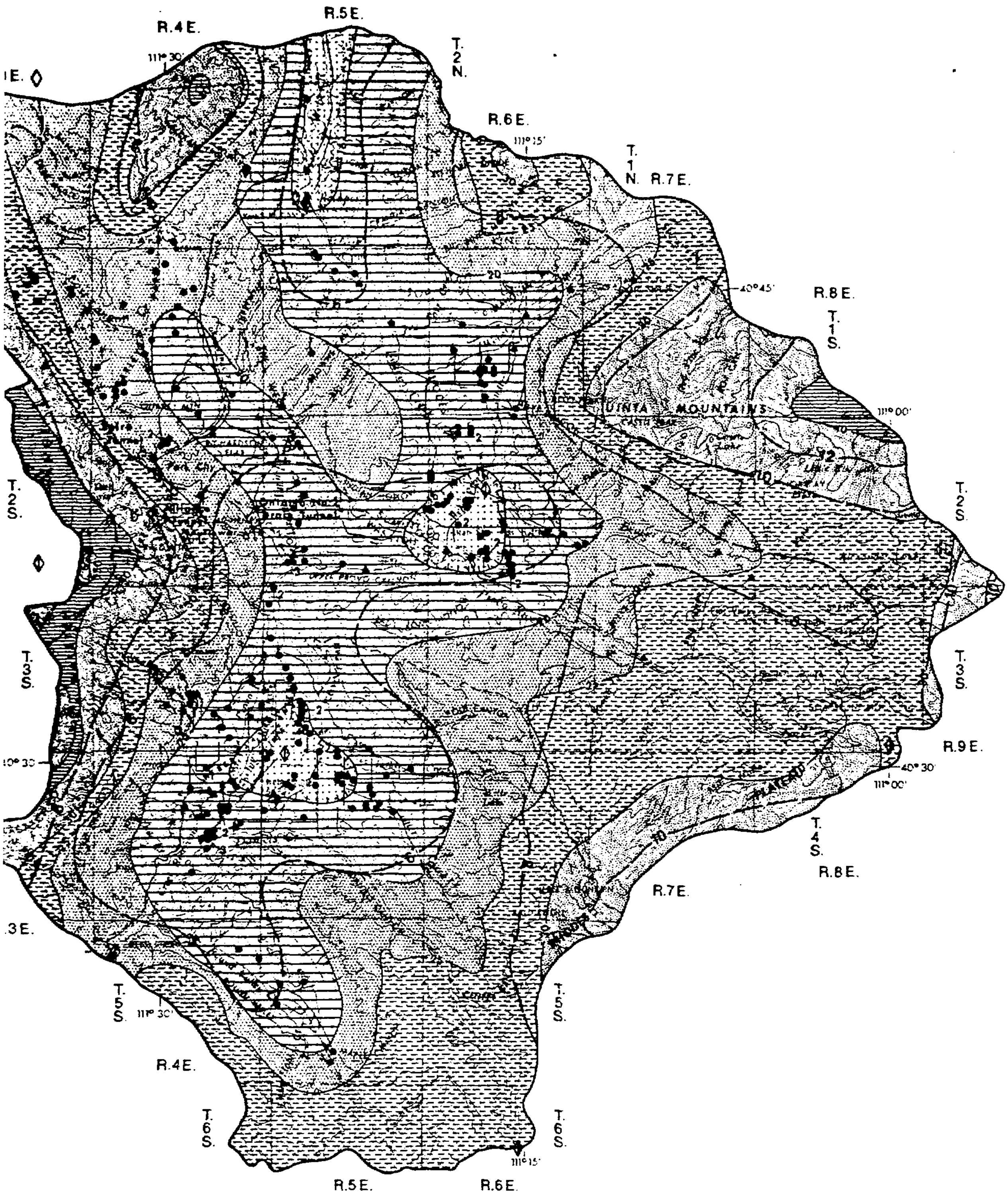


EXPLANATION

HYDROLOGY

Well

Spring

Number indicates more than one well or spring at site

Stream-gaging station

Tunnel

WEATHER STATIONS

Precipitation only

Precipitation and temperature

Precipitation, temperature, and evaporation

Storage precipitation gage

30 Line of equal normal annual precipitation, in inches

6 Line of equal normal May-September precipitation, in inches

Zones of normal annual precipitation, in inches

50 40 30 25 20 16

Boundary of the study area

5 0 5 Miles

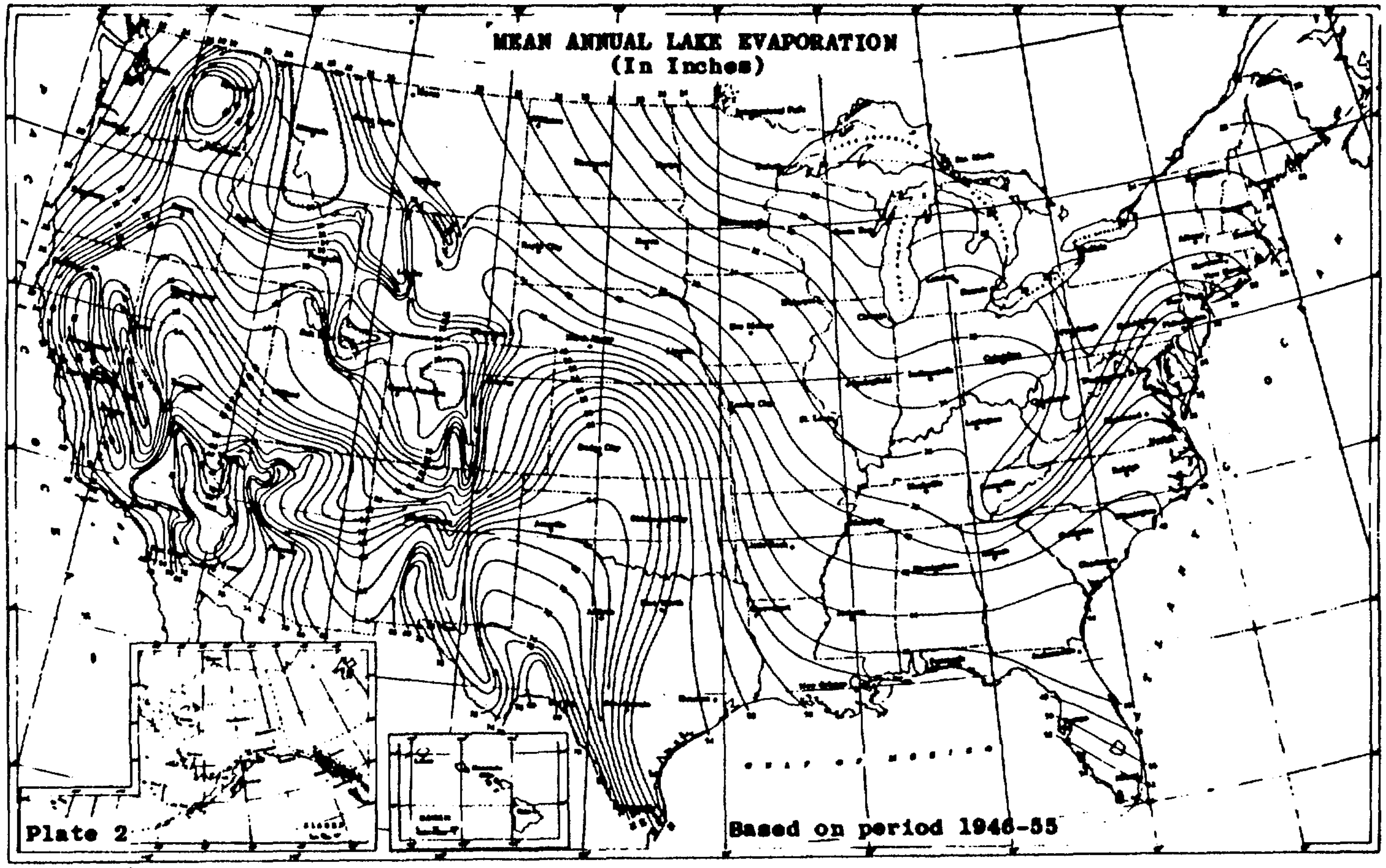
5 0 5 Kilometers

CONTOUR INTERVAL 200 FEET
DATUM IS MEAN SEA LEVEL

U.S. Geological Survey (AMS) series: Salt Lake ... Wyoming (1963)

Hydrology by C. H. Baker, Jr., 1969
Precipitation data from U.S. Weather Bureau, 1963

MAP OF THE HEBER-KAMAS-PARK CITY AREA, NORTH-CENTRAL UTAH, SHOWING LOCATIONS OF WELLS, ·RINGS, STREAM-GAGING STATIONS, AND WEATHER STATIONS AND NORMAL MAY-SEPTEMBER PRECIPITATION interpolate between contours



Source: Climatic Atlas of the United States, U.S. Department of Commerce, National Climatic Center, Ashville, N.C., 1979.

FIGURE 4
MEAN ANNUAL LAKE EVAPORATION
(IN INCHES)

Fig. 2

Source: Climatic Atlas of the United States, U.S. Department of Commerce, National Climatic Center, Ashville, N.C., 1979.

FIGURE 5
NORMAL ANNUAL TOTAL PRECIPITATION (INCHES)

Ref. 3
(Contains Ref. 2)

Uncontrolled Hazardous Waste Site Ranking System

A Users Manual
(HW-10)

Originally Published in
the July 16, 1982, *Federal Register*

United States
Environmental Protection
Agency

1984

Ref. #4

ecology and environment, inc.

4105 EAST FLORIDA AVENUE, SUITE 360, DENVER, COLORADO 80222, TEL. 303-757-4984

International Specialists in the Environmental Sciences

TO : FILE

FROM : Jeff Holcomb, E&E FIT Engineer Jeff Holcomb

DATE : July 12, 1985

SUBJECT: Richardson Flat Tailings

The files pertaining to United Park City Mines at the State of Utah Department of Health Water Pollution Board contained information on the tailings deposited at Richardson Flat. The tailings were piped from the Ontario Mine Shaft south of Park City at a rate of 63 gallons per minute. This information is in the NPPES permit section files and can be obtained by contacting Mr. Steve McNiel of the Water Pollution Board.

REF. 77

RECORD OF COMMUNICATION

☑ PHONE CALL ☐ DISCUSSION ☐ FIELD TRIP ☐ CONFERENCE

☐ OTHER (SPECIFY) (801) 533-6121

(Record of item checked above)

TO: Marv Maxell
Utah State Dept. Health

FROM: Marc L. Gesink

DATE: 4/20/84

TIME:

SUBJECT: Use of Pacific Bridge Well, Prospector Square

SUMMARY OF COMMUNICATION

When asked if the Pacific Bridge well is used for water supply presently, Marv said yes, it is used as a backup source of supply when demand is high.

CONCLUSIONS, ACTION TAKEN OR REQUIRED

Used well in ground water use, HRS.

INFORMATION COPIES
TO:

EPA Form 1300-6 (7-72) REPLACES EPA HQ FORM 5300-3 WHICH MAY BE USED UNTIL SUPPLY IS EXHAUSTED.

REF. # 1

RECORD OF COMMUNICATION	☑ PHONE CALL ☐ DISCUSSION ☐ FIELD TRIP ☐ CONFERENCE ☐ OTHER (SPECIFY) (801) 649-9321 (Record of item checked above)	
TO: Jennifer Harrington Park City - Planner	FROM: Marc L. Gesink E&E	DATE 4/23/84 TIME

SUBJECT
Population, Park City, UT

SUMMARY OF COMMUNICATION

When asked about population served by municipal water supplies, Jennifer states that it fluctuates from approximately 4500 people in the summer to about 15,000 in the peak of the winter ski season.

CONCLUSIONS, ACTION TAKEN OR REQUIRED

Used this info for target, HRS

INFORMATION COPIES
TO:

EPA Form 1300-6 (7-72) REPLACES EPA HQ FORM 5300-3 WHICH MAY BE USED UNTIL SUPPLY IS EXHAUSTED.

For HQ

RECORD OF COMMUNICATION

☒ PHONE CALL ☐ DISCUSSION ☐ FIELD TRIP ☐ CONFERENCE

☐ OTHER (SPECIFY)

(Record of item checked above)

TO:	FROM:	DATE
Fred Duberow J.J. Johnson & Assoc. (801) 649-9811	Marc L. Gesink E&E	4/23/84 TIME

SUBJECT

Land irrigated by supply wells drawing from alluvium or Woodside Fm.

SUMMARY OF COMMUNICATION

When asked acreage irrigated from aquifer of concern, Fred gave an answer based on his experience in the area. He said none within 3 miles.

CONCLUSIONS, ACTION TAKEN OR REQUIRED

Used info on Targets, HRS

INFORMATION COPIES
TO:

(8 of 4)

RECORD OF COMMUNICATION	☑ PHONE CALL ☐ DISCUSSION ☐ FIELD TRIP ☐ CONFERENCE ☐ OTHER (SPECIFY) (Record of item checked above)	
TO: Fred Dubrow	FROM: Marc L. Gesink E&E	DATE 4/23/84 TIME

SUBJECT

Use of surface water

SUMMARY OF COMMUNICATION

When asked use of surface water diverted within 3 miles downstream of site, Fred stated irrigation of hay, pasture grass.

CONCLUSIONS, ACTION TAKEN OR REQUIRED

Used information for target, HRS

INFORMATION COPIES
TO:

EPA Form 1300-6 (7-72) REPLACES EPA HQ FORM 5300-3 WHICH MAY BE USED UNTIL SUPPLY IS EXHAUSTED.

Ref. # 10

ecology and environment, inc.

4105 EAST FLORIDA AVENUE, SUITE 350, DENVER, COLORADO 80222, TEL. 303-757-4984

International Specialists in the Environmental Sciences

TO : FILE

FROM : Jeff Holcomb Jeff Holcomb

DATE : July 12, 1985

SUBJECT: Waste Quantity, Richardson Flat Tailings

In a telephone conversation between Jeff Holcomb, Ecology and Environment, Inc., and Kerry Gee, Geologist/Engineer, United Park City Mines, the following information was provided by Mr. Gee:

- the estimated quantity of waste or tailings material at Richardson Flat is in excess of 2 million tons

- depth of the tailings varies from 0 to 10 feet

ENVIRONMENT[illegible] PROTECTION AGENCY
Environm[illegible]l Services Division

CHAIN OF CUSTODY RECORD

236-5052 REF. #11

[illegible]ION 8
186[illegible] [illegible]coln Street
Denver, Coloradc 80295

PROJ. NO.	PROJECT NAME
R8-8505-27	Richardson Flat Tailings

SAMPLERS: (Signature) [signatures]

Water Data – 7/8/85

REMARKS

STAT. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	wide-mouth 8-oz glass jar	1-l poly	TAG #	Analysis Type	Comments
RT-SO-1	6/19/85	1510	X		Upgradient Background	1	1		8-26082	Metals/Cyanide	
RT-SO-4	6/19/85	1540	X		SE portion of tailings	1	1		8-26085		
RT-SO-5	6/19/85	1545	X		mid-portion of tailings	1	1		8-26086		
RT-SO-6	6/19/85	1555	X		WSW-portion of tailings	1	1		8-26087		
RT-SO-7	6/19/85	1630	X		Mid-upper tailings	1	1		8-26097		
RT-SW-1	6/20/85	1055		X	Upstream Background Silver Creek	2		2	8-26116 8-26118	Metals Sulfate	
RT-SW-2	6/20/85	1245		X	Silver Creek by RR track	2		2	8-26119 8-26121		
RT-SW-3	6/20/85	1110		X	Keetly Junction Trussel	2		2	8-26122 8-26063		
RT-SW-4	6/20/85	1025		X	SE Tailings; Intermittent Stream	2		2	8-26064 8-26066		
RT-SW-5	6/20/85	1220		X	Int. Stream; 60' S of dike road	2		2	8-26067 8-26069		
RT-SW-6	6/20/85	1240		X	Int. Stream; @ culvert	6		6	8-26070 ✓ 8-26076 ✓ 8-26079 ✓ 8-26072 ✓ 8-26078 ✓ 8-26081 ✓		triple volume for lab QC

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Susan C. Kennedy	6/20/85 1500				

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)

Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks
		[signature]	6/21/85 0930	

Distribution: Original Accompanies Shipment; First Copy to Coordinator Field Files; Second Copy to Representative of Inspected Facility

Split Samples: ☐ Accepted ☐ Declined ______ Signature

Received by Federal Express on 6/21/85 – Opened chest 6/21/85 Seals Intact

8-2047

ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, DENVER, COLORADO

RT-1

LABORATORY SERVICES REQUEST

PROJECT NAME Richardson Flat Tailings PROJECT CODE R8-8505-27 SAMPLES COLL. BY S. Kennedy DATE 6/20/85

SAMPLES RECEIVED AT LABORATORY BY ______ DATE ______ DATA REVIEWED BY ______

ANALYST INITIALS							
STATION CODE				RT-SW-1	RT-SW-2	RT-SW-3	RT-SW-4
SAMPLE COLL. TIME				1055	1245	1110	1025
STATION DESCRIPTION AND REMARKS	GW-1 Background well #1	GW-2 Well #2	GW-3 Well #3	SW-1 Background Silver Creek 6-20-85	SW-2 mid-Silver Creek 6-20-85	SW-3 down-gradient Silver Creek 6-20-85	SW-4 SE Tailings 6-20-85

CODE	PARAMETER														
1-2 poly (water)	TASK 1&2 METALS		Dissolved		Dissolved		Dissolved		Total ~~Dissolved~~ *		Total ~~Dissolved~~ *		Total ~~Dissolved~~ *		Total ~~Dissolved~~ *
	Aluminum	✓		✓		✓		✓	172	✓	77	✓	370	✓	450
	Antimony	✓		✓		✓		✓	21	✓	15	✓	35	✓	19
	Arsenic	✓		✓		✓		✓	14	✓	11	✓	65	✓	33.
	Barium	✓		✓		✓		✓	36	✓	41	✓	53	✓	119.
	Beryllium	✓		✓		✓		✓	<10	✓	<10	✓	<10	✓	<10
	Cadmium	✓		✓		✓		✓	<5	✓	<5	✓	<5	✓	<5
	Calcium	✓		✓		✓		✓	137000	✓	119000	✓	124000	✓	128000
	Chromium	✓		✓		✓		✓	<5	✓	<5	✓	<5	✓	<5
	Cobalt	✓		✓		✓		✓	<5	✓	<5	✓	<5	✓	<5
	Copper	✓		✓		✓		✓	12	✓	9	✓	60	✓	18
	Iron	✓		✓		✓		✓	725	✓	389	✓	2290	✓	1570
	Lead	✓		✓		✓		✓	147	✓	93	✓	1985	✓	237
	Magnesium	✓		✓		✓		✓	22200	✓	24000	✓	26000	✓	35400
	Manganese	✓		✓		✓		✓	764	✓	434	✓	727	✓	602
	Mercury	✓		✓		✓		✓	0.2	✓	0.1	✓	0.57	✓	0.1

results in mg/l unless otherwise indicated, heavy metals in ug/l, pH in units, turbidity in JTU, specific conductance in μ mhos/cm, as per STORET.

* GPO: 1979-680-570

R8EPA-012 (Rev. 11-82)

	RT-SW-1	RT-SW-2	RT-SW-3	RT-SW-4
pH:	7.33	7.54	7.47	7.26
Temp: °C	21	21	19	20
Sp. Cond. umhos/cm	600	600	550	700

TF

RT-2

ENVIRONMENTAL PRO[illegible]TION AGENCY
REGION VIII, DENVER, COLORADO

LABORATORY SERVICES REQUEST

PROJECT NAME Richardson Flat Tailings PROJECT CODE R8-8505-27 SAMPLES COLL. BY S Kennedy DATE 6/20/85

SAMPLES RECEIVED AT LABORATORY BY ______ DATE ______ DATA REVIEWED BY ______

ANALYST INITIALS

STATION DESCRIPTION Note!!

AND REMARKS Station Numbers on Container tops for SW-2 & SW-5 are opposite designation as tags. $SO_4^=$ data indicate, suggest tag reversal. M.W. Lammering

STATION CODE									RT-SW-1		RT-SW-2		RT-SW-3		RT-SW-4
SAMPLE COLL. TIME									1055		1245		1110		1025
STATION DESCRIPTION AND REMARKS		GW-1 Background Well #1 SL		GW-2 Well #2 SL		GW-3 Well #3 SL			SW-1 Background Silver Creek 6-20-85		SW-2 Mid-Silver Creek 6-20-85		SW-3 down-gradient Silver Creek 6-20-85		SW-4 SE Tailings 6-20-85
CODE	PARAMETER		Dissolved		Dissolved		Dissolved	SK	Total ~~Dissolved~~	SK	Total ~~Dissolved~~	SK	Total ~~Dissolved~~	SK	Total ~~Dissolved~~
12-poly (H_2O)	Nickel	✓		✓		✓		✓	<30	✓	<30	✓	<30	✓	<30
	Potassium	✓		✓		✓		✓	—	✓	—	✓	—	✓	—
	Selenium	✓		✓		✓		✓	<5	✓	<5	✓	<5	✓	<5
	Silver	✓		✓		✓		✓	<5	✓	<5	✓	<5	✓	<5
	Sodium	✓		✓		✓		✓	31700	✓	25600	✓	25200	✓	36500
	Thallium	✓		✓		✓		✓	<100	✓	<100	✓	<100	✓	<100
	Tin	✓		✓		✓		✓	—	✓	—	✓	—	✓	—
	Vanadium	✓		✓		✓		✓	<10	✓	<10		<10		<10
	Zinc	✓		✓		✓			2690		1650		2730		350
	TASK 3 METAL														
	Cyanide	✓		✓		✓		✓		X	ØAH	X	ØAH	X	ØAH
	SPECIAL ANION														
	Sulfate	✓		✓		✓		✓	284	✓	963	✓	210	✓	218
	Chloride								47		27		28		50

	RT-SW-1	RT-SW-2	RT-SW-3	RT-SW-4
pH:	7.33	7.54	7.47	7.26
Temp: °C	21	21	19	20
Cond: µmho/cm	600	600	550	700

RT-4
6/19/85

ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, DENVER, COLORADO

LABORATORY SERVICES REQUEST

PROJECT NAME Richardson Flat Tailings PROJECT CODE R8-8505-27 SAMPLES COLL. BY S Kennedy DATE 6/20/85

SAMPLES RECEIVED AT LABORATORY BY ______ DATE ______ DATA REVIEWED BY ______

ANALYST INITIALS								
STATION CODE		RT-SW-5	RT-SW-6	RT-SO-1			RT-SO-4	RT-SO-5
SAMPLE COLL. TIME		1220	1240				1540	1545
STATION DESCRIPTION AND REMARKS		SW-5 mid-tailings 6-20-85	SW-6 down-gradient tailings 6-20-85	SO-1 background soil 6-19-85	SO-2 downgradient soil (E) SL	SO-3 downgradient soil (W) SL	SO-4 SE tailings 6-19-85	SO-5 mid-tailings 6-19-85
CODE	PARAMETER	Total	Total					
	Nickel	✓ <30	✓ <30	✓	✓	✓	✓	✓
	~~Potassium~~	✓	✓	✓	✓	✓	✓	✓
	Selenium	✓ <5	✓ <5	✓	✓	✓	✓	✓
	Silver	✓ <5	✓ <5	✓	✓	✓	✓	✓
	Sodium	✓ 29000	✓ 37300	✓	✓	✓	✓	✓
	Thallium	✓ <100	✓ <100	✓	✓	✓	✓	✓
	~~Tin~~	✓	✓	✓	✓	✓	✓	✓
	Vanadium	✓ <10	✓ <10	✓	✓	✓	✓	✓
	Zinc	✓ 1410	✓ 812	✓	✓	✓	✓	✓
	TASK 3 METAL							
	Cyanide	X 9/18/85	X 9/18/85	✓	✓	✓	✓	✓
	SPECIAL ANION							
	Sulfate	✓ 222	✓ 909					
	Chloride	40	33					

results in mg/l unless otherwise indicated, heavy metals in ug/l, pH in units, turbidity in JTU, specific conductance in µ mhos/cm, as per STORET. ★ GPO: 1979-680-570

R8EPA-012
(Rev. 11-82)

pH:	7.40	7.40
Temp:	21	21
Cond.:	1200	1400

RT-2

ENVIRONMENTAL PRO[TECT]ION AGENCY
REGION VIII, DENVER, COLORADO

LABORATORY SERVICES REQUEST

PROJECT NAME Richardson Flat Tailings PROJECT CODE R8-8505-27 SAMPLES COLL. BY S Kennedy DATE 6/20/85

SAMPLES RECEIVED AT LABORATORY BY ______ DATE ______ DATA REVIEWED BY ______

STATION CODE					RT-SW-1	RT-SW-2	RT-SW-3	RT-SW-4
SAMPLE COLL. TIME					1055	1245	1110	1025
STATION DESCRIPTION AND REMARKS	* Note!! Station Numbers on Container tops for SW-2 & SW-5 are opposite designation on tags. $SO_4^=$ data indicate, suggest tag reversal. M.W. Lammering	GW-1 Background Well #1 [illegible]	GW-2 Well #2 [illegible]	GW-3 Well #3 [illegible]	SW-1 Background Silver Creek 6-20-85	SW-2 mid-Silver Creek 6-20-85	SW-3 down-gradient Silver Creek 6-20-85	SW-4 SE Tailings 6-20-85
CODE	PARAMETER	Dissolved	Dissolved	Dissolved	~~Dissolved~~ Total	SK ~~Dissolved~~ Total	SK ~~Dissolved~~ Total	SK ~~Dissolved~~ Total
1l-poly (H_2O)	Nickel	✓	✓	✓	✓ <30	✓ <30	✓ <30	✓ <30
	Potassium	✓	✓	✓	✓	✓	✓	✓
	Selenium	✓	✓	✓	✓ <5	✓ <5	✓ <5	✓ <5
	Silver	✓	✓	✓	✓ <5	✓ <5	✓ <5	✓ <5
	Sodium	✓	✓	✓	✓ 31700	✓ 25600	✓ 25200	✓ 36500
	Thallium	✓	✓	✓	✓ <100	✓ <100	✓ <100	✓ <100
	Tin	✓	✓	✓	✓	✓	✓	✓
	Vanadium	✓	✓	✓	✓ <10	✓ <10	<10	<10
	Zinc	✓	✓	✓	2690	1650	2730	350
	TASK 3 METAL							
	Cyanide	✓	✓	✓	✓	X ØpH	X ØpH	X ØpH
	SPECIAL ANION					222*		
	Sulfate	✓	✓	✓	✓ 284	✓ ~~963~~	✓ 210	✓ 218
	Chloride				47	27	28	50

results in mg/l unless otherwise indicated, heavy metals in ug/l, pH in units, turbidity in JTU, specific conductance in µ mhos/cm, as per STORET.

* GPO: 1979-680-570

R8EPA-012 (Rev. 11-82)

	SW-1	SW-2	SW-3	SW-4
pH:	7.33	7.54	7.47	7.26
temp: °C	21	21	19	20
	600	600	550	700

RT-3

ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, DENVER, COLORADO

LABORATORY SERVICES REQUEST

PROJECT NAME Richardson Flat Tailings PROJECT CODE R8-8505-27 SAMPLES COLL. BY S. Kennedy DATE 6/19/85 6/20/85

SAMPLES RECEIVED AT LABORATORY BY ______ DATE ______ DATA REVIEWED BY ______

STATION CODE		RT-SW-5	RT-SW-6	RT-SO-1			RT-SO-4	RT-SO-5
SAMPLE COLL. TIME		1220	1240	1510			1540	1545
STATION DESCRIPTION AND REMARKS		SW-5 mid-tailings 6-20-85	SW-6 downgradient tailings 6-20-85	SO-1 background soil 6-19-85	SO-2 downgradient soil (E) SK	SO-3 downgradient soil (W) SK	SO-4 SE tailings	SO-5 mid-tailings
CODE	PARAMETER							
1-l poly (water)	TASK 1&2 METALS	Total	Total					
	Aluminum	✓ <30	✓ 35	✓	✓	✓	✓	✓
8-oz jar (soil)	Antimony	✓ 13	✓ 7	✓	✓	✓	✓	✓
	Arsenic	✓ 27	✓ 12	✓	✓	✓	✓	✓
	Barium	✓ 26	✓ 27	✓	✓	✓	✓	✓
	Beryllium	✓ <10	✓ <10	✓	✓	✓	✓	✓
	Cadmium	✓ <5	✓ <5	✓	✓	✓	✓	✓
	Calcium	✓ 252000	✓ 287000	✓	✓	✓	✓	✓
	Chromium	✓ <5	✓ <5	✓	✓	✓	✓	✓
	Cobalt	✓ <5	✓ <5	✓	✓	✓	✓	✓
	Copper	✓ <5	✓ <5	✓	✓	✓	✓	✓
	Iron	✓ 507	✓ 215	✓	✓	✓	✓	✓
	Lead	✓ 42	✓ <30	✓	✓	✓	✓	✓
	Magnesium	✓ 55400	✓ 59200	✓	✓	✓	✓	✓
	Manganese	✓ 1654	✓ 2566	✓	✓	✓	✓	✓
	Mercury	✓ <0.1	✓ <0.1	✓	✓	✓	✓	✓

results in mg/l unless otherwise indicated, heavy metals in ug/l, pH in units, turbidity in JTU, specific conductance in µ mhos/cm, as per STORET.

★ GPO: 1979-680-570

R8EPA-012 (Rev. 11-82)

	SW-5	SW-6
pH:	7.40	7.40
temp: °C	21	21
Cond: µmhos/cm	1200	1400

ENVIRONMENTAL PRO TION AGENCY
REGION VIII, DENVER, COLORADO

LABORATORY SERVICES REQUEST

RT-4
6/19/85

PROJECT NAME Richardson Flat Tailings PROJECT CODE R8-8505-27 SAMPLES COLL. BY S Kennedy DATE 6/20/85

SAMPLES RECEIVED AT LABORATORY BY ______ DATE ______ DATA REVIEWED BY ______

STATION CODE		RT-SW-5	RT-SW-6	RT-SO-1			RT-SO-4	RT-SO-5
SAMPLE COLL. TIME		1220	1240				1540	1545
STATION DESCRIPTION AND REMARKS		SW-5 mid-tailings 6-20-85	SW-6 down-gradient tailings 6-20-85	SO-1 background soil 6-19-85	SO-2 downgradient soil (E) Sb	SO-3 downgradient soil (W) Sb	SO-4 SE tailings 6-19-85	SO-5 mid-tailings 6-19-85
CODE	PARAMETER	Total	Total					
	Nickel	✓ <30	✓ <30	✓	✓	✓	✓	✓
	~~Potassium~~	✓	✓	✓	✓	✓	✓	✓
	Selenium	✓ <5	✓ <5	✓	✓	✓	✓	✓
	Silver	✓ <5	✓ <5	✓	✓	✓	✓	✓
	Sodium	✓ 29000	✓ 37300	✓	✓	✓	✓	✓
	Thallium	✓ <100	✓ <100	✓	✓	✓	✓	✓
	~~Tin~~	✓	✓	✓	✓	✓	✓	✓
	Vanadium	✓ <10	✓ <10	✓	✓	✓	✓	✓
	Zinc	✓ 1410	✓ 812	✓	✓	✓	✓	✓
	TASK 3 METAL							
	Cyanide	X Sb	X Sb	✓	✓	✓	✓	✓
	SPECIAL ANION	*						
	Sulfate	✓ ~~322~~ 963	✓ 909					
	Chloride	40	33					

results in mg/l unless otherwise indicated, heavy metals in ug/l, pH in units, turbidity in JTU, specific conductance in µ mhos/cm, as per STORET. ★ GPO: 1979-680-570 R8EPA-012 (Rev. 11-82)

pH: 7.40 7.40
Temp: 21 21
1100 1400

Sb

Ref. # 11 Rec'd 7-12-85 JAH

Transmittal of Analytical Data

TO: Jeff Holcomb DATE: July 11, 1985

FROM: M. W. Lammering LAB: Region VIII

PROJECT CODE: R8-8505-27 PROJECT NAME: Richardson Flat Tailings Utah

COMPLETE REPORT: YES X NO ____. What samples/parameters are currently on analytical backlog: ____

EXPECTED DATE OF COMPLETION: ____.

Were RCRA/CERCLA approved analytical methods used throughout?

YES X NO ___ If No, explain: ____

Did Quality Control for all samples meet laboratory acceptance criteria:
YES X NO ___. If No, explain: ____

What corrective actions were taken: ____

Any unusual characteristics of sample(s) Color, Turbidity, Sediment, Odor, Phase Separations: YES ____ NO ____. If No, please explain ____

No unusual characteristics

Were samples collected properly Correct container type,: Preservation, tags properly filled out and attached: Containers clean proper volume: Container lekage, etc. YES ~~X~~ MWL NO X . If No, explain:

Tags on SW-2 and SW-5 may have been reversed — anion aliquots

Did laboratory receive adequate advance notice of sample arriving?: Completed LSR Forms with expected dates, stations, parameters?: YES X NO ____.
If No, explain: ____

Were LSRs arriving with samples adequately filled out. Liquid and semi-solid/solid samples on separate LSRs. All parameters individually listed except p.p. organics (grouped). YES X NO ____ If No, explain: ____

Other Comments: ____

RT-1

ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, DENVER, COLORADO

LABORATORY SERVICES REQUEST

PROJECT NAME Richardson Flat Tailings PROJECT CODE R8-8565-27 SAMPLES COLL. BY S. Kennedy DATE 6/20/85

SAMPLES RECEIVED AT LABORATORY BY ______ DATE ______ DATA REVIEWED BY ______

ANALYST INITIALS

STATION CODE								RT-SW-1		RTSW-2		RT-SW-3		RT-SW-4	
SAMPLE COLL. TIME								1055		1245		1110		1025	
STATION DESCRIPTION AND REMARKS		GW-1 Background Well #1		GW-2 Well #2		GW-3 Well #3		SW-1 Background Silver Creek 6-20-85		SW-2 mid-Silver Creek 6-20-85		SW-3 downgradient Silver Creek 6-20-85		SW-4 SE Tailings 6-20-85	
CODE	PARAMETER								Total		Total		Total		Total
1-l poly (water)	TASK 1 METALS		Dissolved		Dissolved		Dissolved		~~Dissolved~~		~~Dissolved~~		~~Dissolved~~		~~Dissolved~~
	Aluminum	✓		✓		✓		✓	172	✓	77	✓	370	✓	450
	Antimony	✓		✓		✓		✓	21	✓	15	✓	35	✓	19
	Arsenic	✓		✓		✓		✓	14	✓	11	✓	65	✓	33
	Barium	✓		✓		✓		✓	36	✓	41	✓	53	✓	119
	Beryllium	✓		✓		✓		✓	<10	✓	<10	✓	<10	✓	<10
	Cadmium	✓		✓		✓		✓	<5	✓	<5	✓	<5	✓	<5
	Calcium	✓		✓		✓		✓	137000	✓	119000	✓	124000	✓	128000
	Chromium	✓		✓		✓		✓	<5	✓	<5	✓	<5	✓	<5
	Cobalt	✓		✓		✓		✓	<5	✓	<5	✓	<5	✓	<5
	Copper	✓		✓		✓		✓	12	✓	9	✓	60	✓	18
	Iron	✓		✓		✓		✓	725	✓	389	✓	2290	✓	1570
	Lead	✓		✓		✓		✓	147	✓	93	✓	1955	✓	237
	Magnesium	✓		✓		✓		✓	22200	✓	24000	✓	26000	✓	35400
	Manganese	✓		✓		✓		✓	764	✓	434	✓	727	✓	602
	Mercury	✓		✓		✓		✓	0.2	✓	0.1	✓	0.57	✓	0.1

All results in mg/l unless otherwise indicated, heavy metals in ug/l, pH in units, turbidity in JTU, specific conductance in μ mhos/cm, as per STORET. ★ GPO: 1979-680-570 R8EPA-012 (Rev. 11-82)

	SW-1	SW-2	SW-3	SW-4
pH:	7.33	7.54	7.47	7.32
temp: °C	21	21	19	20
	600	600	580	700

ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, DENVER, COLORADO

RT-2

LABORATORY SERVICES REQUEST

PROJECT NAME Richardson Flat Tailings PROJECT CODE R8-8505-21 SAMPLES COLL. BY S Kenning DATE 6/20/85

SAMPLES RECEIVED AT LABORATORY BY ______ DATE ______ DATA REVIEWED BY ______

STATION CODE								RT-SW-1		RT-SW-2		RT-SW-3		RT-SW-4	
SAMPLE COLL. TIME								1055		1245		1110		1025	
STATION DESCRIPTION AND REMARKS Station Numbers on Container tops for SW-2 & SW-5 are opposite designation on tags. $SO_4^=$ data indicate, suggest tag reversal. M.W. Lammering		GW-1 Background Well #1 SK		GW-2 Well #2 SK		GW-3 Well #3 SK		SW-1 Background Silver Creek 6-20-85		SW-2 mid-Silver Creek 6-20-85		SW-3 downgradient Silver Creek 6-20-85		SW-4 SE Tailings 6-20-85	
CODE	PARAMETER		Dissolved		Dissolved		Dissolved		Total ~~Dissolved~~	SK	Total ~~Dissolved~~	SK	Total ~~Dissolved~~	SK	Total ~~Dissolved~~
Le-poly (H_2O)	Nickel	✓		✓		✓		✓	<30	✓	<30	✓	<30	✓	<30
	Potassium	✓		✓		✓		✓	—	✓	—	✓	—	✓	—
	Selenium	✓		✓		✓		✓	<5	✓	<5	✓	<5	✓	<5
	Silver	✓		✓		✓		✓	<5	✓	<5	✓	<5	✓	<5
	Sodium	✓		✓		✓		✓	31700	✓	25600	✓	25200	✓	36500
	Thallium	✓		✓		✓		✓	<100	✓	<100	✓	<100	✓	<100
	Tin	✓		✓		✓		✓	—	✓	—	✓	—	✓	—
	Vanadium	✓		✓		✓		✓	<10	✓	<10		<10		<10
	Zinc	✓		✓		✓			2690		1650		2730		350
	TEST 3 TOTAL														
	Cyanide	✓		✓		✓		✓		X	DRH	X	DRH	X	DRH
	SPECIAL ACTION														
	Sulfate	✓		✓		✓		✓	284	✓	963	✓	310	✓	218
	Chloride								47		27		28		50

All results in mg/l unless otherwise indicated, heavy metals in ug/l, pH in units, turbidity in JTU, specific conductance in μ mhos/cm, as per STORET.

★ GPO: 1979-680-570

R8EPA-012 (Rev. 11-82)

pH	7.33	7.54	7.41	7.26
temp. °C	21	21	19	20

CPT-7

ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, DENVER, COLORADO

LABORATORY SERVICES REQUEST

PROJECT NAME Richardson Flat Tailings PROJECT CODE R8-8505-27 SAMPLES COLL. BY S. Kennedy DATE 6/19/85

SAMPLES RECEIVED AT LABORATORY BY ______ DATE ______ DATA REVIEWED BY ______

ANALYST INITIALS																
STATION CODE		RT-50-6		RT-50-7												
SAMPLE COLL. TIME		1555		1630												
STATION DESCRIPTION AND REMARKS		50-6 NW Tailings 6-19-85		50-7 mid-upper Tailings 6-19-85												
CODE	PARAMETER															
8-oz jar	Nickel	✓	9.6	✓	16											
	Potassium	✓	—	✓	—											
	Selenium	✓	<400	✓	<300											
	Silver	✓	24	✓	22											
	Sodium	✓	3280	✓	2280											
	Thallium	✓	<18	✓	<15											
	Tin	~~✓~~	—	~~✓~~	—											
	Vanadium	✓	4.8	✓	6.5											
	Zinc	✓	5870	✓	3780											
	% solids		90.6		93.7											
	TASK 3 METAL															
	Cyanide	✓		✓												
	SPECIAL ANION															
	Sulfate															

All results in mg/1 unless otherwise indicated, heavy metals in ug/1, pH in units, turbidity in JTU, specific conductance in μ mhos/cm, as per STORET.

☆ GPO: 1979-680-570

R8EPA-012 (Rev. 11-82)

CPT-8.

ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, DENVER, COLORADO

LABORATORY SERVICES REQUEST

PROJECT NAME Richardson Flat Tailings PROJECT CODE RT-8505-27 SAMPLES COLL. BY S. Kennedy DATE 6/19/85

SAMPLES RECEIVED AT LABORATORY BY ______ DATE ______ DATA REVIEWED BY ______

ANALYST INITIALS						
STATION CODE		RT-50-6		RT-50-7		
SAMPLE COLL. TIME		1555		1630		
STATION DESCRIPTION AND REMARKS		50-6 NW Tailings 6-19-85		50-7 mid-upper tailings 6-19-85		
CODE	PARAMETER					
8-oz jar	Total Metals	✓		✓		
	Aluminum	✓	794	✓	1340	
	Antimony	✓	<400	✓	<300	
	Arsenic	✓	900	✓	600	
	Barium	✓	6.2	✓	27	
	Beryllium	✓	<1.8	✓	<1.5	
	Cadmium	✓	80	✓	58	
	Calcium	✓	16900	✓	75200	
	Chromium	✓	7.8	✓	19	
	Cobalt	✓	<0.9	✓	1.5	
	Copper	✓	371	✓	961	
	Iron	✓	154000	✓	106000	
	Lead	✓	7010	✓	8530	
	Magnesium	✓	3960	✓	13100	
	Manganese	✓	510	✓	5150	
	Mercury	✓	0.14	✓	0.50	

All results in mg/l unless otherwise indicated, heavy metals in ug/1, pH in units, turbidity in JTU, specific conductance in μ mhos/cm, as per STORET.

★ GPO: 1979-680-570

RBEPA-012
(Rev. 11-82)

F8.

RT-3

ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, DENVER, COLORADO

LABORATORY SERVICES REQUEST

PROJECT NAME Richardson Flat Tailings PROJECT CODE R8-8505-27 SAMPLES COLL. BY S Kennedy DATE 6/11/85 6/20/85

SAMPLES RECEIVED AT LABORATORY BY ______ DATE ______ DATA REVIEWED BY ______

ANALYST INITIALS								
STATION CODE		RT-SW-5	RT-SW-6	RT-SO-1			RT-SO-4	RT-SO-5
SAMPLE COLL. TIME		1220	1240	1510			1540	1545
STATION DESCRIPTION AND REMARKS		SW-5 mid-tailings 6-20-85	SW-6 downgradient tailings 6-20-85	SO-1 background soil 6-19-85	~~SO-2 downgradient soil (E)~~ SK	~~SO-3 downgradient soil (W)~~ SK	SO-4 SE Tailings	SO-5 mid-tailings
CODE	PARAMETER							
1-l poly (water)	TASK 1&2 METALS	Total	Total					
	Aluminum	✓ <30	✓ 35	✓ 14400	✓	✓	✓ 3440	✓ 863
8-oz jar (soil)	Antimony	✓ 13	✓ 7	✓ 39	✓	✓	✓ <200	✓ <200
	Arsenic	✓ 27	✓ 12	✓ 58	✓	✓	✓ 3600	✓ 1500
	Barium	✓ 26	✓ 27	✓ 178	✓	✓	✓ 105	✓ 58
	Beryllium	✓ <10	✓ <10	✓ <1.6	✓	✓	✓ <1.9	✓ <1.4
	Cadmium	✓ <5	✓ <5	✓ 17	✓	✓	✓ 47	✓ 40
	Calcium	✓ 252000	✓ 287000	✓ 8200	✓	✓	✓ 45600	✓ 49500
	Chromium	✓ <5	✓ <5	✓ 24	✓	✓	✓ 60	✓ 15
	Cobalt	✓ <5	✓ <5	✓ 11	✓	✓	✓ 6.9	✓ 2.3
	Copper	✓ <5	✓ <5	✓ 94	✓	✓	✓ 227	✓ 181
	Iron	✓ 507	✓ 215	✓ 24000	✓	✓	✓ 30700	✓ 19900
	Lead	✓ 42	✓ <30	✓ 1110	✓	✓	✓ 3320	✓ 2650
	Magnesium	✓ 55400	✓ 59200	✓ 4990	✓	✓	✓ 14600	✓ 15300
	Manganese	✓ 1654	✓ 2566	✓ 879	✓	✓	✓ 1650	✓ 1810
	Mercury	✓ <0.1	✓ <0.1	✓ 0.59	✓	✓	✓ 1.70	✓ 2.61

All results in mg/1 unless otherwise indicated, heavy metals in ug/1, pH in units, turbidity in JTU, specific conductance in µ mhos/cm, as per STORET. ☆ GPO: 1979-680-570 R8EPA-012 (Rev. 11-82)

pH: 7.40 7.40
Temp: °C 21 21

ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, DENVER, COLORADO

LABORATORY SERVICES REQUEST

RT-1
6/17/85

PROJECT NAME Richardson Flat Tailings PROJECT CODE R8-8505-27 SAMPLES COLL. BY S Kennedy DATE 6/5/85

SAMPLES RECEIVED AT LABORATORY BY ______ DATE ______ DATA REVIEWED BY ______

ANALYST INITIALS

STATION CODE		RT-SW-5	RT-SW-6	RT-SO-1			RT-SO-4	RT-SO-5
SAMPLE COLL. TIME		1220	1240				1540	1545
STATION DESCRIPTION AND REMARKS		SW-5 mid-tailings 6-20-85	SW-6 down-gradient tailings 6-20-85	SO-1 background soil 6-14-85	~~SO-2 downgradient soil (E)~~	~~SO-3 downgradient soil (W)~~	SO-4 SE Tailings 6-19-85	SO-5 mid-tailings 6-19-85
CODE	PARAMETER	Total	Total					
	Nickel	✓ <30	✓ <30	✓ 12	✓	✓	✓ 59	✓ 5.2
	Potassium	✓	✓	✓	✓	✓	✓	✓
	Selenium	✓ <5	✓ <5	✓ <16	✓	✓	✓ <20	✓ <300
	Silver	✓ <5	✓ <5	✓ 6.7	✓	✓	✓ 20	✓ 19
	Sodium	✓ 29000	✓ 37300	✓ 1020	✓	✓	✓ 3470	✓ 2960
	Thallium	✓ <100	✓ <100	✓ <16	✓	✓	✓ <19	✓ <14
	Tin	✓	✓	✓	✓	✓	✓	✓
	Vanadium	✓ <10	✓ <10	✓ 37	✓	✓	✓ 9.1	✓ 3.5
	Zinc	✓ 1410	✓ 812	✓ 1570	✓	✓	✓ 6360	✓ 5400
	% Solids			97.4			95.8	96.9
	TASK 3 METAL							
	Cyanide	X [illegible]	X [illegible]	✓	✓	✓	✓	✓
	SPECIAL ANION							
	Sulfate	✓ 222	✓ 909					
	Chloride	40	33					

All results in mg/l unless otherwise indicated, heavy metals in ug/l, pH in units, turbidity in JTU, specific conductance in µmhos/cm, as per STORET.

★ GPO: 1979-680-570

R8EPA-012
(Rev. 11-82)

	SW-5	SW-6
pH:	7.40	7.40
Temp:	21	21
Cond.:	1200	1400

ENVIRONMENT, PROTECTION AGENCY
Environmental Services Division

REGION 8
1860 Lincoln Street
Denver, Colorado 80295

CHAIN OF CUSTODY RECORD

PROJ. NO. R8-8505-27
PROJECT NAME Richardson Flat Tailings

SAMPLERS: (Signature) [signature] Susan C Kennedy

STAT. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	8-oz wide-mouth glass jar	1-l poly	TAG #	Analysis Type	Comments
RT-SO-1	6/19/85	1510	X		Upgradient Background	1	1		8-26082	Metals/Cyanide	
RT-SO-4	6/19/85	1540	X		SE portion of tailings	1	1		8-26085	↓	
RT-SO-5	6/19/85	1545	X		mid-portion of tailings	1	1		8-26086		
RT-SO-6	6/19/85	1555	X		WSW-portion of tailings	1	1		8-26087		
RT-SO-7	6/19/85	1630	X		Mid-upper tailings	1	1		8-26097		
RT-SW-1	6/20/85	1055		X	Upstream Background Silver Creek	2		2	8-26116 8-26118	metals. Sulfate	
RT-SW-2	6/20/85	1245		X	Silver Creek by RR track	2		2	8-26119 8-26121	↓	
RT-SW-3	6/20/85	1110		X	Keetly Junction Trussel	2		2	8-26122 8-26063		
RT-SW-4	6/20/85	1025		X	SE Tailings; Intermittent Stream	2		2	8-26064 8-26066		
RT-SW-5	6/20/85	1220		X	Int. Stream; 60' S of dike road	2		2	8-26067 8-26069		
RT-SW-6	6/20/85	1240		X	Int. Stream; @ culvert	6		6	8-26070 8-26076 8-26079 8-26072 8-26078 8-26081		triple volume for lab QC

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Susan C Kennedy	6/20/85 1500				

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)

Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks
		[signature]	6/21/85 0930	

Distribution: Original Accompanies Shipment; First Copy to Coordinator Field Files; Second Copy to Representative of Inspected Facility

Split Samples: ☐ Accepted ☐ Declined ______ Signature

Received by Federal Express on 6/21/85 - Opened chest 6/21/85 Seals Intact

8-2047

Ref. #11

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
ONE DENVER PLACE — 999 18TH STREET — SUITE 1300
DENVER, COLORADO 80202-2413

OCT 8 1985

Ref: 8ES

Ecology and Environment, Inc.
4105 E. Florida Avenue, Suite 350
Denver, Colorado 80222

Attn: Susan Kennedy

Dear Susan:

As we discussed in our October 3 telephone conversation, I am providing you with a partial release of data for Richardson Flats Tailings.

Included are: total metals, dissolved metals, cyanide and sulfate analyses for four ground water stations; mercury and percent solids for six soil stations. The samples were taken August 2 and were analyzed for cyanide on August 27, which did exceed the fourteen day holding time.

Yet to be completed are: total metals for the six soil stations. These results should be available around October 8. At that time, we will provide a full, final data package to you that will supersede this partial release. Please call me if you have any questions.

Sincerely,

Joan K. Barnes

Joan K. Barnes, Acting Chief
Analytical Support Branch

Enclosures

cc: Keith Schwab (W/O Enclosure)
Kelsey Land (W/O Enclosure)

ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, DENVER, COLORADO

LABORATORY SERVICES REQUEST

3

PROJECT NAME RF PROJECT CODE 854527 SAMPLES COLL. BY D. Tuesday DATE 8-2-85

SAMPLES RECEIVED AT LABORATORY BY ______ DATE ______ DATA REVIEWED BY ______

ANALYST INITIALS

STATION CODE	RF GW-1	RF GW-3	RF GW-4	RF GW-1	RF GW-2	RF GW-3	RF GW-4
SAMPLE COLL. TIME	1700	1915	2000	1700	1630	1915	2000
STATION DESCRIPTION AND ~~REMARKS~~ Partial Report	RT-1	MW #1	mon. well #4	RT-1	Mon. well #2	mon. well #1	mon. well #4

CODE	PARAMETER	Totals	Totals	Totals	Dissolved	Dissolved	Dissolved	Dissolved
	TASK 1&2 METALS							
	Aluminum	1040	80700	83400	<30	<30	<30	<30
	Antimony	<5	<5	<5	<5	<5	<5	<5
	Arsenic	<5	78	70	<5	9	<5	9
	Barium	83	1534	1354	78	99	104	104
	Beryllium	<10	<10	<10	<10	<10	<10	<10
	Cadmium	<5	42	48	<5	<5	<5	<5
	Calcium mg/l	45	352	332	47	307	254	254
	Chromium	<5	98	104	<5	<5	<5	<5
	Cobalt	<5	46	48	<5	67	10	10
	Copper	<5	1583	1350	<5	<5	<5	<5
	Iron	958	126000	130000	<10	14800	376	300
	Lead	<30	588	527	<30	<30	<30	<30
	Magnesium mg/l	9.960	88	85	9.8	70	56	56
	Manganese	20	2230	2070	11	9990	924	903
	Mercury	<0.1	0.70	0.60	<0.1	<0.1	<0.1	<0.1

All results in mg/l unless otherwise indicated, heavy metals in ug/l, pH in units, turbidity in JTU, specific conductance in μmhos/cm, as per STORET. * GPO: 1979-680-570 R8EPA-012 (Rev. 11-82)

pH
Temp.

ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, DENVER, COLORADO

LABORATORY SERVICES REQUEST

#6

PROJECT NAME RF   PROJECT CODE 8505-27   SAMPLES COLL. BY D. Tuesday   DATE 8-2-85

SAMPLES RECEIVED AT LABORATORY BY ____   DATE ____   DATA REVIEWED BY ____

ANALYST INITIALS

STATION CODE		RF GW-1	RF GW-3	RF GW-4	RF GW-1	RF GW-2	RF GW-3	RF GW-4
SAMPLE COLL. TIME		1700	1915	2000	1700	1630	1915	2000
STATION DESCRIPTION AND REMARKS Partial Report		RT-1	mon. well #1	mon. well #4	RT-1	mon. well #2	mon. well #1	mon. well #4
CODE	PARAMETER	✓ Totals	✓ Totals	✓ Totals	✓ Dissolved	✓ Dissolved	✓ Dissolved	✓ Dissolved
	Nickel	<30	88	82	<30	<30	<30	<30
	~~Potassium~~							
	Selenium	<5	<5	<5	<5	<5	<5	<5
	Silver	<5	<5	<5	<5	<5	<5	<5
	Sodium mg/L	16	44	44	16	52	42	44
	Thallium	<100	<100	<100	<100	<100	<100	<100
	~~Tin~~							
	Vanadium	<10	262	266	<10	<10	<10	<10
	Zinc	<5	650	569	6	144	<5	<5
	TASK 3 METAL							
	Cyanide	✓ <10	✓ <10	✓ <10	✓	✓	✓	✓
	Tag #	8-27748	8-27747	8-27583				
	SPECIAL ANION							
	Sulfate	✓ 35	✓ 625	✓ 1025	✓	✓ 775	✓	✓

All results in mg/l unless otherwise indicated, heavy metals in ug/l, pH in units, turbidity in JTU, specific conductance in μ mhos/cm, as per STORET.   ★ GPO: 1979-680-570   R8EPA-012 (Rev. 11-82)

pH

Temp

ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, DENVER, COLORADO

LABORATORY SERVICES REQUEST

PROJECT NAME RF PROJECT CODE 8505-27 SAMPLES COLL. BY D Tuesday DATE 8-1-85 8-2-85

SAMPLES RECEIVED AT LABORATORY BY ______ DATE ______ DATA REVIEWED BY ______

ANALYST INITIALS								
STATION CODE		RF SS-1	RF SS-2	RF SS-3	RF SS-4	RF SS-5	RF SS-6	RF-GW-2
SAMPLE COLL. TIME		8-1 1211	8-2 1300	8-2 1400	8-2 1430	8-2 1600	8-2 1000	1630
STATION DESCRIPTION AND REMARKS metals H_2O preserved w/ HNO_3 CN^- " " " NaOH		Split spoon Hole RT-1	Split spoon Hole RT-1	Split spoon Hole RT-2	Split spoon Hole RT-2	Split spoon Hole RT-2	Split spoon Hole RT-2	Min well #2
		Partial Report						
CODE	PARAMETER	Totals	Totals	Totals	Totals	Totals	Totals	Totals
1 l poly (H_2O)	TASK 1&2 METALS	✓	✓	✓	✓	✓	✓	✓
8 oz jar (soil)	Aluminum							4920
	Antimony							~~[illegible]~~ 63
	Arsenic							~~210~~ 34
	Barium							~~26~~ 2655
	Beryllium							<10
	Cadmium							16
	Calcium mg/l Cal.ly							34
	Chromium							42
	Cobalt							80
	Copper							190
	Iron							26300
	Lead							1080
	Magnesium mg/l Cal.ly							72
	Manganese							10400
	Mercury	<.05	<.05	0.94	1.97	2.26	0.40	0.1

Results in mg/l unless otherwise indicated, heavy metals in ug/l, pH in units, turbidity in JTU, specific conductance in µ mhos/cm, as per STORET. * GPO: 1979-680-570 R8EPA-012 (Rev. 11-82)

pH
Temp.

Soils are ug/gm

ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, DENVER COLORADO

LABORATORY SERVICES REQUEST

PROJECT NAME RF   PROJECT CODE 8505-27   SAMPLES COLL. BY D. Tuesday   DATE 8-1-85 8-2-85

SAMPLES RECEIVED AT LABORATORY BY ______   DATE ______   DATA REVIEWED BY ______

ANALYST INITIALS

STATION CODE	RF-SS-1	RF SS-2	RF SS-3	RF SS-4	RF SS-5	RF SS-6	RF-GW-2
SAMPLE COLL. TIME	8-1 1211	8-1 1300	1400	1430	1600	1600	1630
STATION DESCRIPTION AND REMARKS metals H_2O preserved w/ HNO_3 CN^- H_2O preserved w/ NaOH	split spoon RT-1	split spoon RT-1	split spoon RT-2	split spoon RT-2	split spoon RT-2	split spoon RT-2	mon well #2

Partial Report

CODE	PARAMETER							
		✓ Total	✓ Total	✓ Total	✓ Total	✓ Total	✓ Total	✓ Total
1l poly (H_2O)	Nickel							30
8 oz jar (Soil)	~~Potassium~~							
	Selenium							<5
	Silver							17
	Sodium mg/l for Aq							54
	Thallium							<100
	~~Tin~~							
	Vanadium							17
	Zinc							2790
	% Solids	79.2	77.4	86.4	88.3	88.9	79.1	
	TASK 3 METAL							
*	Cyanide							✓ 2000 Cay 85-27?
	SPECIAL ANION							
	Sulfate							✓ 775

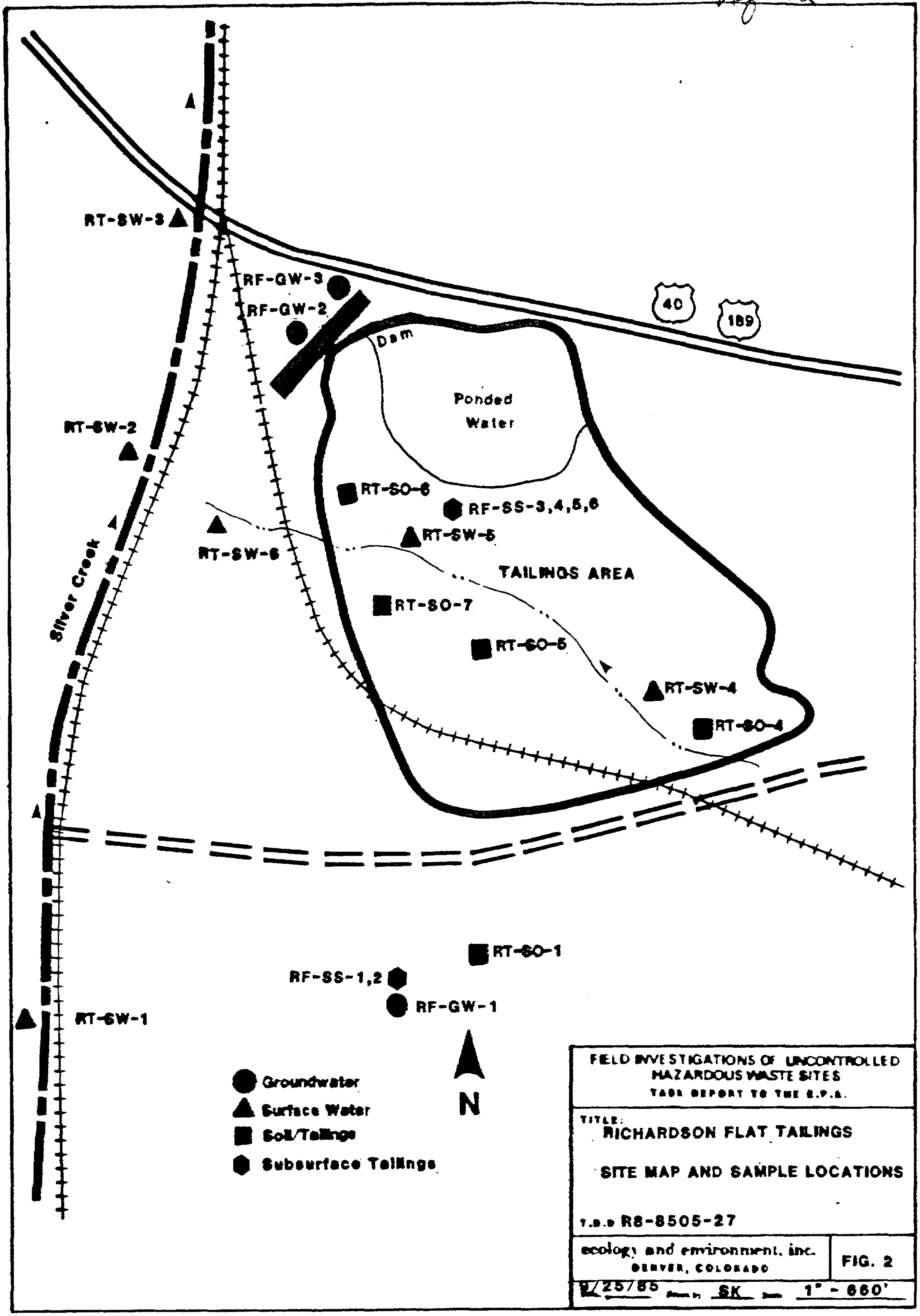
All results in mg/l unless otherwise indicated, heavy metals in ug/l, pH in units, turbidity in JTU, specific conductance in μ mhos/cm, as per STORET.   ☆ GPO: 1979-680-570   RBEPA-017 (Rev. 11-82)

* ug/L

pH
Temp

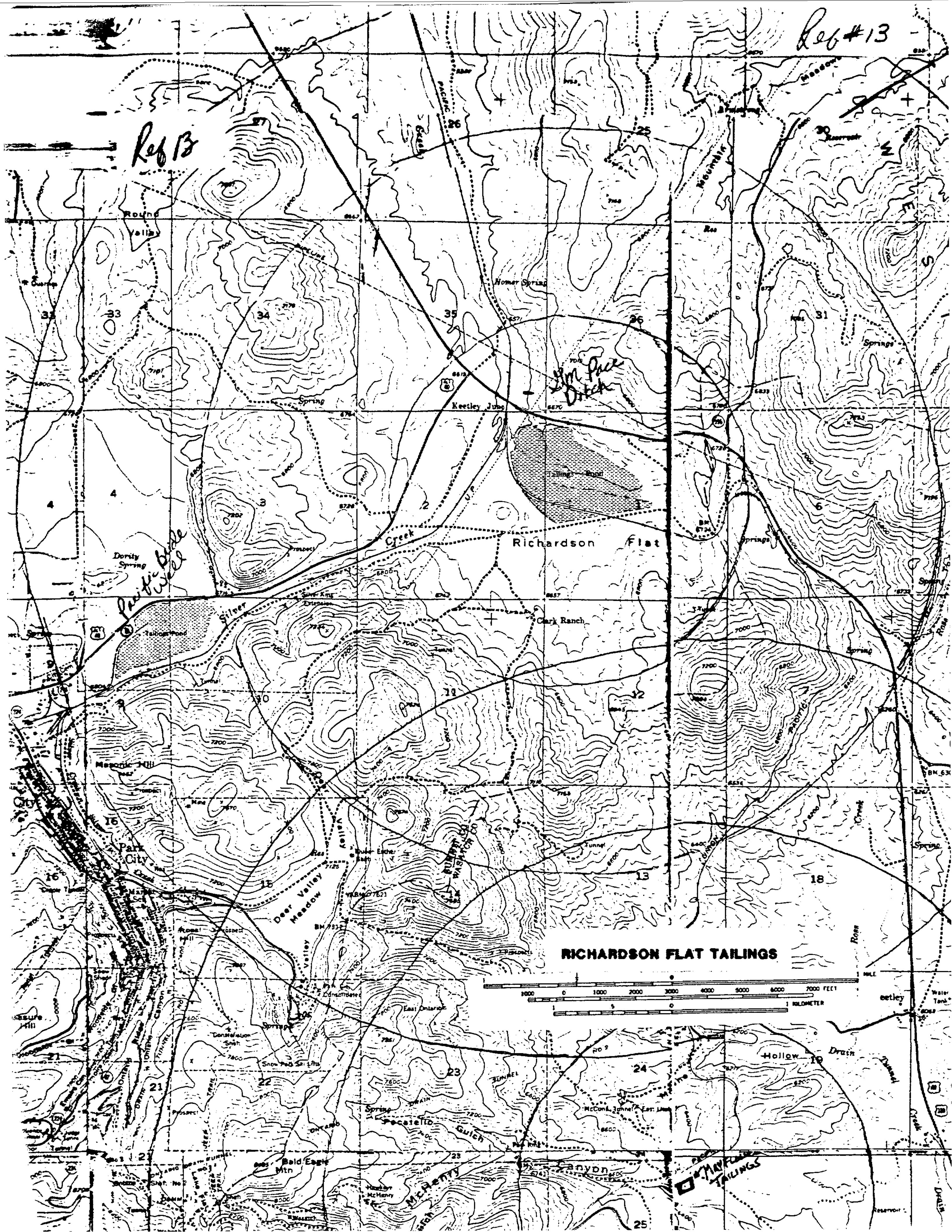
Ⓡ Suspect possibly reported value due to SCN⁻ interference

Key #12



RT-SW-3
RF-GW-3
RF-GW-2
40
189
Dam
Ponded Water
RT-SW-2
RT-SO-6
RF-SS-3,4,5,6
RT-SW-5
RT-SW-6
TAILINGS AREA
Silver Creek
RT-SO-7
RT-SO-5
RT-SW-4
RT-SO-4
RT-SO-1
RF-SS-1,2
RF-GW-1
RT-SW-1
N
Groundwater
Surface Water
Soil/Tailings
Subsurface Tailings
FIELD INVESTIGATIONS OF UNCONTROLLED HAZARDOUS WASTE SITES
TASK REPORT TO THE E.P.A.
TITLE: RICHARDSON FLAT TAILINGS
SITE MAP AND SAMPLE LOCATIONS
T.D.D R8-8505-27
ecology and environment, inc.
DENVER, COLORADO
FIG. 2
9/25/85
SK
1" - 660'

Ref #13



RICHARDSON FLAT TAILINGS
Ref 13
Pacific Bridge Well
Jim Pace Ditch
Mayflower Tailings
Richardson Flat
Tailings Pond
Keetley Junc
Clark Ranch
Silver Creek
Round Valley
Dority Spring
Homer Spring
Masonic Hill
Park City
Deer Valley Meadow
Bald Eagle Mtn
Pocatello Gulch
McHenry Canyon
Hollow
East Ontario
Ontario Canyon
Mountain
Springs
SUMMIT CO
WASATCH CO
3000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 0 1 KILOMETER
1 MILE

Ref. 14

RECORD OF COMMUNICATION	☒ PHONE CALL ☐ DISCUSSION ☐ FIELD TRIP ☐ CONFERENCE ☐ OTHER (SPECIFY) (801) 532-4031 (Record of item checked above)	
TO: Kerry Gee Geologist/Engineer United Park City Mines Co.	FROM: Susan Kennedy C&E Susan C Kennedy	DATE 17 July 1985 TIME 0945

SUBJECT
Amount of Waste at Richardson Flat Tailings

SUMMARY OF COMMUNICATION

Spoke with secretary; Mr. Gee sent a letter yesterday (16 July) stating his best estimation of tailings material at Richardson Flat is approximately 49,417,400 cubic feet.

CONCLUSIONS, ACTION TAKEN OR REQUIRED

INFORMATION COPIES
TO:

EPA Form 1300-6 (7-72) REPLACES EPA HQ FORM 5300-3 WHICH MAY BE USED UNTIL SUPPLY IS EXHAUSTED.

Ref 15

RECORD OF COMMUNICATION	[x] PHONE CALL ☐ DISCUSSION ☐ FIELD TRIP ☐ CONFERENCE ☐ OTHER (SPECIFY) (801) 649-9321 (Record of item checked above)	
TO: Jerry Gibbs, Public Works Director, Park City, Utah	FROM: Susan Kennedy, E&E	DATE 17 July 1985
	Sue Kennedy	TIME 0930

SUBJECT

Groundwater use in Richardson Flat vicinity

SUMMARY OF COMMUNICATION

The following information was provided by Mr. Gibbs:

- the only well within a 3-mile radius of Richardson Flat tailings potentially used as a drinking water source is the Pacific Bridge well. The well is used as a backup supply when demand is high, however, Mr. Gibbs stated it hasn't been used for two years.
- verification of our (E&E) mapped location of the Pacific Bridge well: SW¼, NE¼, NE¼, S.9, T2S, R4E.
- no agricultural irrigation from groundwater sources in a 3-mile radius of Richardson Flat tailings.

CONCLUSIONS, ACTION TAKEN OR REQUIRED

INFORMATION COPIES

TO:

EPA Form 1300-6 (7-72) REPLACES EPA HQ FORM 5300-3 WHICH MAY BE USED UNTIL SUPPLY IS EXHAUSTED.

Ref. 16

RECORD OF COMMUNICATION	☒ PHONE CALL ☐ DISCUSSION ☐ FIELD TRIP ☐ CONFERENCE ☐ OTHER (SPECIFY) (801) 533-4207 (Record of item checked above)

TO:	FROM:	DATE / TIME
Larry Mize Bureau of Public Water Supply Utah State Dept. of Health	Susan Kennedy E&E Sue C. Kennedy	DATE 17 July 85 TIME 1020

SUBJECT

Surface Water use near Richardson Flat

SUMMARY OF COMMUNICATION

When asked if surface water from Silver Creek between Richardson Flat and Atkinson was used as a drinking water source, he said no, it was not. ~~He said to his knowledge~~

CONCLUSIONS, ACTION TAKEN OR REQUIRED

INFORMATION COPIES
TO:

Rf. 17

RECORD OF COMMUNICATION	☑ PHONE CALL ☐ DISCUSSION ☐ FIELD TRIP ☐ CONFERENCE ☐ OTHER (SPECIFY) (801) 533-7206 (Record of item checked above)	
TO: Jeff Anderson Div. of Water Rights Utah Dept. of Nat. Resources	FROM: Susan Kennedy (E&E) Susan C Kennedy	DATE 7/18/85 TIME 1430

SUBJECT

Irrigation diversions off Silver Creek

SUMMARY OF COMMUNICATION

The following information was provided by Mr. Anderson:

- 3 water diversions from Silver Creek exist in the area near Richardson Flat tailings; 2 of the diversions are upstream of the tailings in T2S, R4E, Sec. 2, and are owned by Silver King Mining Co. and Union Lime & Stone Co.-- probably used for moving tailings to pond area.
- The third diversion is located 500 feet N and 625 feet west of the southeast corner of Sec. 35, T1S, R4E, and is registered under Silver Creek Irrigation Company. This diversion is downstream of Richardson Flat Tailings, and the water is used to irrigate pastureland (cattle grazing) in Sections 35, 26, 22, 23, 10 and 11, T1S, R4E.

CONCLUSIONS, ACTION TAKEN OR REQUIRED

INFORMATION COPIES

TO:

EPA Form 1300-6 (7-72) REPLACES EPA HQ FORM 5300-3 WHICH MAY BE USED UNTIL SUPPLY IS EXHAUSTED.

Ref. 10

RECORD OF COMMUNICATION

☒ PHONE CALL ☐ DISCUSSION ☐ FIELD TRIP ☐ CONFERENCE

☐ OTHER (SPECIFY) (801) 649-9811

(Record of item checked above)

TO: Mark Oliver
J.J. Johnson & Assoc.

FROM: Susan Kennedy
Sue C Kennedy

DATE 7/18/85

TIME 1500

SUBJECT

Irrigation diversions downstream of Richardson Flat Tailings

SUMMARY OF COMMUNICATION

When asked how many acres are irrigated by surface water diversions off Silver Creek within three miles of downstream flow from Richardson Flat tailings, Mr. Oliver stated:

- His approximation of land irrigated by water from Silver Creek in the area downstream of Prospector Square tailings (just NE of Park City) is 650 acres. Approximately 90% of the irrigated acreage (approx. 585 acres) is downstream and within 3 miles of Richardson Flat tailings.
- Crops irrigated are pasture grass and alfalfa

CONCLUSIONS, ACTION TAKEN OR REQUIRED

INFORMATION COPIES

TO:

Ref 14

RECORD OF COMMUNICATION	[x] PHONE CALL [ ] DISCUSSION [ ] FIELD TRIP [ ] CONFERENCE [ ] OTHER (SPECIFY) (801) 649-9583 (Record of item checked above)	
TO: Stanley B. Pace Silver Creek Irrigation Co.	FROM: Susan Kennedy, E&E Susan C Kennedy	DATE 7/18/85 TIME 1530

SUBJECT

Location of surface water diversions downstream of Richardson Flat Tailings

SUMMARY OF COMMUNICATION

Mr. Pace described the location of the "GM Pace Ditch" as about ½ mile east of Quinn Junction or the junction of Highways 40 and 248 referred to as Keetley Junc on the USGS topographic map. This location description matches closely with that described by Jeff Anderson, Utah Division of Water Rights.

The above-mentioned is the only surface water diversion from Silver Creek for irrigation purposes within three miles of downstream flow from Richardson Flat tailings.

CONCLUSIONS, ACTION TAKEN OR REQUIRED

INFORMATION COPIES

TO:

EPA Form 1300-6 (7-72) REPLACES EPA HQ FORM 5300-3 WHICH MAY BE USED UNTIL SUPPLY IS EXHAUSTED.